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SCIENTIFIC MANAGEMENT AND SOCIAL FACTORS

IN October 1952, the Anglo-American Council on Productivity appointed a specialist team to investigate the American approach to the improvement of methods of manufacture and the continuous reduction of operating costs. The team, which visited the United States early in 1953, was concerned with the effect of planning, control, budgeting and costing on the improvement of manufacturing methods; with the relation between design and methods of manufacture; with the means used on the factory floor to improve methods; with the effect of administrative arrangements on methods; and with the educational arrangements for training industrial engineers and for giving tuition in industrial engineering to managements and young workers. The report, entitled "Industrial Engineering", which the team has now produced* sets forth a number of recommendations intended to indicate the steps which British industry should take in the interest of productivity, and it also includes a supplementary report on 'industrial engineering' education in the United States.

Although some of the recommendations involve action by government as well as by industry, both the reports are of general interest to the scientist and to the technologist, as will appear from the definition of industrial engineering adopted by the team for the purposes of these reports. Industrial engineering is regarded as the application of basic scientific and engineering knowledge and certain analytical techniques to the methods of operating an organization in industry and other appropriate fields. It requires investigation into the economic advantages of one policy as against another and implementation of the most suitable procedure for raising productive efficiency. To this end performance and costs need to be checked constantly. Industrial engineering, the report continues, is a staff activity of management, and is concerned with decisions on what to produce, the design of the product, standardization, the influence of cost analysis on methods of production, the investigation of these methods, planning and control of production, calculation of what is the most efficient machinery for the job, layout of plant and handling of materials, design of tools, maintenance of plant, time study, motion study, incentives, method of calculation of wages, suggestion schemes and industrial relations. It requires consideration to be given to the communication of new ideas among senior and junior managers, among supervisors, and to and from workers on the shop floor. It also requires careful regard to the well-being, attitudes and opinions of workers.

The definition is given at length, not so much because the team seriously recommends that the British Standards Institution should set up a committee to deal with the terminology of the whole field of industrial engineering, as because it illustrates

* British Productivity Council. Industrial Engineering—Report of a visit to the U.S.A. in 1953 of a British Specialist Team on Industrial Engineering. Pp. xii+116. (London: British Productivity Council, 1954.) 5*s*.

the way in which the team has adopted the term to cover activities which are inherent in industrial administration or scientific management, as conceived by such writers as Taylor, Fayol, Urwick, Mayo and Whitehead. It is at least arguable whether it is wise on the grounds of its mechanical connotations alone to use such a term as 'engineering' to cover activities which depend particularly on human co-operation. That alone could be a hindrance to much that is already being done in the field of human relations in industry by the Science and Industry Committee reconstituted early this year. Samuel Butler's "Erewhon" could still be a salutary warning to those who use the words 'machine' or 'machinery' for organization without due forethought.

At the outset, the report emphasizes the bearing of the social and industrial background on the approach to problems of productivity, and its opening chapter sketches with considerable skill the features of the American background which are significant in this connexion, and more especially those which are also to be found in Britain. Nevertheless, this recognition of the importance of the climate of opinion does not lead the team to examine the means by which that climate of opinion may be made more favourable to the improvement of productivity. Accordingly, recommendations which may be unexceptionable in themselves are made with little appreciation of the magnitude of the repercussions involved. The correct objective may indeed be indicated, but the means recommended sometimes suggest a degree of naïvety or even arrogance that, to say the least, is disturbing.

For example, in stressing the importance of shift work in order that expensive machinery may be used economically, the team rightly recognizes that it is desirable that retail shops and restaurants should be open for the workers coming off duty. When it goes on to suggest legal sanction for such arrangements, it shows little conception of what is thereby involved. Alternative means depending on individual enterprise and initiative are more likely to provide what is required. For the rest, patient but determined education of public opinion and, at the most, no more legal action than is required to prevent restraints contrary to the public interest are the more hopeful lines of advance. It may be surmized that the presence of any investigator from the National Institute of Industrial Psychology among the members of the team would have prevented any such mistake.

So, too, the team's study of industrial engineering education in the United States does not prevent it from making a similarly naïve recommendation that "industrial engineering studies in universities and technical colleges, whether as single subjects or as courses, should be expanded". It is assumed without question that industrial engineering studies are appropriate, both for universities and for technical colleges, and although the report notes that more than half those who enter the courses in American universities fail to complete them, the wastage is accepted without criticism. Whether these four-year courses of industrial engineering with their high concentration on subjects concerned with the application of knowledge rather than basic science are appropriate in a university is not discussed, nor is there any comment on the proposals to replace such four-year courses by less crowded five-year courses.

The team recognizes indeed, so far as Great Britain is concerned, the danger of over-hasty development of 'industrial engineering' studies in the universities, and it makes clear that it is not asking for any change of standards. In fact, although in the United States, out of 127,550 engineering students in 1951–52 there were estimated to be 5,067 industrial engineering students attending sixty schools, while there were thirty-one accredited courses as well as thirteen in mechanical engineering carrying accredited industrial engineering options, the team seems to look to development in the technical colleges rather than in the universities in Britain. It recommends that technical colleges should offer more single specialist courses in such subjects where industry is willing to support them, and that technical colleges should develop further short courses to serve the needs of small businesses. It also looks to the development of the sandwich diploma courses which are being tried in some technical colleges, and to the co-operation of industry in such courses and in the release of employees for part-time day attendance.

The team recognizes the value of participation by the technical colleges in research in the fields covered by its definition of industrial engineering, but the suggestion for courses in industrial engineering is of dubious value. The promotion of contacts between teachers and industry, the encouragement of research and interchange of staff both between Britain and the United States and between Britain and the Continent of Europe are much more likely to be fruitful and assist the expansion which the team recommends.

As has been indicated, a main weakness of the discussion of the educational aspect of the subject in this report is the absence of any clear conception of the functions of a university and of the relative position of university and technical college in regard to technical and vocational training. With that goes a complete indifference to the importance of educating public opinion on the need for new attitudes to shift-work, to motion study and time study, incentives, redundancy and the like. Even in regard to safety, there is nothing more specific than the recommendation that much more education is required on this subject in factories.

By and large, the recommendations of this report endorse many of the projects which have already been taken up by the Science and Industry Committee, and the findings of a number of investigations already completed, such as those of J. F. Scott and B. P. Lynton for the British Institute of Management and of Dr. W. H. Scott of the Department of Social Science in the University of Liverpool. As regards fiscal matters, however, on which the Advisory Council for Scientific Policy hesitated in its report last year, the team is entirely uninhibited. It recommends that the annual depreciation allowance should be revised to facilitate the more rapid writing-down

of machinery and equipment. It condemns the effects of present taxation on business and suggests that a more liberal import licensing policy should be adopted to encourage firms to obtain new equipment essential for increasing productivity but not available in Great Britain. It also recommends that the facilities available to small firms for obtaining finance for capital investment should be more widely publicized and used, and that trade and trade associations, including the trade unions, should be legally required, where they do not already do so, to publish any rules or agreements which bind their members.

Such recommendations obviously bear on the utilization of the results of research and the encouragement of research itself, and though one would not have expected to find reference to that aspect of increased productivity in a report under this title, there are in fact references to the need for further effort to encourage the rapid application of the results of research and to the assistance which more efficient services for the dissemination of technical information could give. An appendix on research in the United States quotes an estimate of 2,000 million dollars expended on research by Federal government agencies in 1952–53, of which 94 per cent was spent on applied research. Two-thirds of the United States expenditure on research and development was for work undertaken by private industry, and such industrial research is dominated by not more than twenty firms, each with research staffs of a thousand or more. Some 3,391 engineers and scientists are employed on research by professional industrial consultants, and more than sixty-five per cent of the 44 million dollars expended on such research comes from the Federal government.

The team noted that the American manufacturer employs consultants more freely than the British manufacturer to advise on the development of new products, changes in range of manufacture and the substitution of new raw materials for old. Specifically it recommends that British firms should make greater use of such consultants and also of the practice termed management audit, entailing a check on the effectiveness of senior management by means of an investigation into the operational efficiency of an organization. Such practices, however, presuppose that the main difficulty in the utilization of existing scientific and technical knowledge, emphasized both in the survey "Industry and Research" made by the Manchester Joint Research Council and by Vera Connell more recently in "The Application of the Results of Research", is the lack of at least one person in the confidence of the management who is competent to appreciate the significance for the firm of new knowledge. If in fact there were the receptivity to new ideas and the readiness to exchange ideas which the team notes as characteristic of American business, that part of the problem of increasing productivity would largely be solved.

We thus come back to the fundamental question of the climate of opinion and of how best we are to promote at all levels—not merely at the top—the outlook and readiness of mind favourable to increased productivity and the modification of processes, practices, ideas and attitudes involved thereby. The team obviously appreciates that close contact between industry and the technical Press is important, but in commending the activities and influence of such journals in the United States in this connexion, it seems scarcely aware of the possibilities in Britain. In this respect the report shows the same lack of imagination as characterizes its treatment of education for management, at the university or at the technical college.

It is refreshing to contrast with this report Prof. A. N. Whitehead's characterization many years ago of the needs of a business organization in discussing technical education in his lectures on "The Aims of Education". Prof. Whitehead pointed out even then that those directing a business organization require an imaginative grasp of the psychologies of populations living under a wide range of conditions, of the complexities of interlocking interests involved in its activities, an imaginative understanding of the social effects of conditions in factories, of the laws of political economy and habits of government, some vision of the binding forces of human organization and some knowledge of the laws of health and fatigue; and, above all, the discipline of character which enables management to take and stand by decisions. Prof. Whitehead rejected then, as forthrightly as Dr. R. M. Hutchins and Sir Hector Hetherington have done in our day, the idea that the university is primarily concerned with the technical or professional knowledge which its students may require for an industrial or other career. A university, he insisted, is an institution uniting young and old in the imaginative consideration of learning: it functions in the preparation for an intellectual career by promoting the imaginative consideration of the general principles underlying that career.

In its report for the quinquennium 1929–34, the University Grants Committee unequivocably affirmed that conception of the functions of the university. Had it been remembered by the productivity team on industrial engineering, some of the recommendations of its report might never have been formulated. We might not indeed have received an adequate discussion of the respective functions of the university and of the technical colleges in training for management and specific recommendations; but the human issues involved would at least have been treated more imaginatively and with less risk of the psychological difficulties into which any discussion of human beings and organization in mechanical terms is liable to run. The over-riding emphasis would have been put in the right place. It is not a new name for management and its myriad activities that is required. The first need is to secure by all possible means the change in opinion in industry at all levels, in parliament, and in the country generally which is necessary for management to get on, without obstruction, with its task of raising the general level of productivity in small firms, as in large. This requires the more rapid and continuous utilization of existing technical knowledge and of new knowledge as it comes along, with all that is implied thereby, and the discarding of obsolete and restrictive practices and their imag-

inative replacement by methods which increase output, lower costs and diminish the hazards, monotony and physical strain which the older methods involved. Along with the task of improving the training for management goes the greater task, in which every bit of assistance that the Press, broadcasting, television, adult education and other means can give will be needed, of securing the climate of opinion in industry and in society which will give wise and progressive management a chance to function.

MEN OF CAMBRIDGE

Alumni Cantabrigienses

A Biographical List of all known Students, Graduates and Holders of Office at the University of Cambridge from the Earliest Times to 1900. Compiled by Dr. J. A. Venn. Part 2: From 1752 to 1900. Volume 6: Square–Zupitza. Pp. iv+627. (Cambridge: At the University Press, 1954.) £10 10*s*. net. Complete set of 10 volumes, 85 guineas net.

THE president of Queens' College, Cambridge, Dr. J. A. Venn, is to be congratulated most heartily on the completion of his stupendous task in preparing for publication and seeing through the press the biographies of some 140,000 members of the University of Cambridge. It has occupied a great part of his time during the past forty-six years, during which he has served in a world war, carried out the duties of a university lecturer, president of a college and vice-chancellor of the University. He has been helped, naturally, by a small staff (for many years one assistant only), by volunteers from individual colleges and last but not least by the financial support and careful, accurate and pleasing workmanship of the University Press. More than six million words were typed and printed in the course of the work—and read over at least twice by the compiler.

It was to Dr. Venn that the idea of this publication was due in the first place. The sources that were used, the names of those who helped and the history of the whole work are given in the prefaces to volumes 1 of the two parts (to 1751 and 1752–1900) of the whole work. We should have liked to see an epilogue at the end of the last volume, in which Dr. Venn could have given an account of his work, looking back over the whole period from 1908 to the present. He gave a taste of the story that he had to tell in his reply to the congratulations of the University conveyed by the Vice-Chancellor at a reception to Dr. and Mrs. Venn organized by the Syndics of the Cambridge University Press on the day of publication of the tenth and last volume.

An analysis of the Fellows of the Royal Society noted in the present volume, more than a hundred in number, shows six presidents (Wollaston, the Duke of Sussex, Stokes, Kelvin, Rayleigh and J. J. Thomson), a predominance of mathematicians, followed by physicists, clerics, public servants, physicians and geologists in that order; among others, a dilettante, a poet (Tennyson) and a banker. Dr. Venn's father, Dr. John Venn, F.R.S., who kept the work going while Dr. Venn was absent on service during the First World War, and who is associated with Dr. Venn in some of the earlier volumes, is one of six generations of the Venn family to graduate in Cambridge. Thomas Young added to his work as a physicist and physician philological skill which enabled him to find the key to the hieroglyphics on the Rosetta Stone. Two hardened Tories were C. P. Yorke, First Lord of the Admiralty, who strongly opposed the abolition of mutilation after execution for treason, and George Whitmore, tutor of St. John's, who addressed his pupils on "a laudable exhibition of justifiable zeal" in breaking the windows of many Dissenters. T. P. Thompson, who at the same time was a midshipman on H.M.S. *Isis* and a Fellow of Queens', had an unusual career: he described his fellowship as "a sort of promotion, which has not often gone along with the rank and dignity of a midshipman". In view of his start, it is not surprising to learn that he was later governor of Sierra Leone, a general in the Army and a Fellow of the Royal Society. Another Fellow, Richard Watson, was simultaneously professor of chemistry and regius professor of divinity, and later held his professorship of divinity along with the bishopric of Llandaff. He was elected to the chair of chemistry, "having never read a syllable on the subject nor seen a single experiment". That may explain why his workshop was afterwards shattered by an explosion; all the same, he is said to have saved the Government £100,000 by advice on the manufacture of gunpowder.

Such notes as the above in the biographies of eminent men may account for Miss Rose Macaulay's description of the "Alumni Cantabrigienses" as a bedside book. The size, weight and small print of the volumes are against such a description, but the biographies do yield many fascinating notes on men in all classes of society. Thus, Thomas Turner, a distinguished physician, was garrotted by ruffians at the age of ninety and was thereby cured of his goitre. John Steggall, who had run away from school and lived with gypsies, came up to Corpus Christi after having been to sea on a whaler and serving in the army in India. He later took Holy Orders and also practised as a surgeon. Edward Tatham preached a famous sermon, 2½ hours long, and left the subject of his discourse to be settled by the learned bench of bishops "who have little to do and do not always do that little". H. H. Vivian, while an undergraduate, brought to England the first camera to pass the London custom house, and afterwards took a daguerreotype, still extant, of a "Breakfast Party" of undergraduates. William Henry Waddington was later naturalized as a French citizen and became in due course Prime Minister of France. William Yardley made the first century in the University match. Edward Wilson of the Antarctic, who reached the South Pole with Captain Scott in 1912, and A. F. R. Wollaston, surgeon and naturalist to the first Mount Everest expedition in 1921, deserve mention among many distinguished Cambridge explorers.

But these volumes can serve many purposes more valuable than that of interesting the casual reader. Sir A. F. Rook has used them to disprove the common view that early subjection to severe athletic strain shortens men's lives, and Mr. Caradog Jones to pursue various sociological studies. The list of biographies provides a mine of information into which inquirers will delve for generations. It is good to know that the University has set up an organization to preserve its archives and to facilitate the work of Dr. Venn's successor, when the burden which he has now set down is taken up again some fifty years hence.

F. J. M. Stratton

LIFE AND SENSES OF THE HONEY BEE

The Dancing Bees

An Account of the Life and Senses of the Honey Bee. By Karl von Frisch. (Translated by Dora Ilse.) Pp. xiv+184+30 plates. (London: Methuen and Co., Ltd., 1954.) 16*s*. net.

KARL VON FRISCH is one of the most distinguished of living experimental zoologists, and it is to him that we are indebted for the greater part of recent advance in knowledge of the behaviour and sense organs of the honey bee. It follows that the publication of a good English translation of the fifth revised edition of "Aus dem Leben der Bienen", a popular and completely up-to-date book by him, is something of an event.

The translation is strictly faithful to the original and has on the whole been admirably done by Dr. Dora Ilse; there are very few places where a slight awkwardness of phrase betrays that it has in fact been put into English by one who is not herself English.

The knowledge of German possessed by most biologists in Great Britain is not by any means so extensive and precise as it should be, and many of us who have perhaps battered an exhausting and uncertain course through the verbose entanglements within which the gems of discovery of the average German biologist are hidden will have come with relief and delight to the scientific papers of von Frisch. Here at last are experiments and results of an unrivalled perfection described with such simple lucidity and logic as to flatter us that our knowledge of the language is, after all, better than we thought. Quite apart from the language itself, what a delight it is to be able to see from the simple narrative style of von Frisch exactly how the investigation developed: to see the extraordinary flashes of insight, the weary plodding after statistical 'certainty'—and no less to be able to appreciate the long treks after false scents and up blind alleys. Nevertheless, if only because several of von Frisch's original papers are by no means easy of access, a great many biologists will welcome the concise simplified account of the beautiful investigations by himself and others, many of them his pupils, which Chapters 7–12 of this book provide. Even the most expert student of bees is likely to profit by reading it, for again and again a descriptive aside or apparently casual observation suggests some new approach to the problems of the evolution of bee organization, or reveals some hitherto unsuspected nicety of adjustment of behaviour to the needs of the colony.

About the rest of the book it is not easy to be quite so enthusiastic. The six introductory chapters are apparently written for readers who are presumed to know nothing at all about either biology in general or bees in particular. There are many gems of precise and vivid description here: thus the honey-stomach is aptly likened to a shopping bag, and a laden pollen collector is described as looking as if she were wearing 'plus fours'. But in spite of such happy phrases the general effect of the extreme simplicity of diction is to give a 'told to the children' air which is somewhat wearisome, and the question is whether a reader who needs this kind of thing will really be able to appreciate the more advanced sections. Although the book has had a great success in Austria and Germany, one wonders if it will meet quite the same need in English-speaking countries, where there are already so many good popular accounts of the natural history of bees and other social insects; and it is against this competition that the book must be judged.

In writing such a popular book it is scarcely possible for an author to avoid all the pitfalls of over-simplification, and the very brilliance of von Frisch's powers of exposition has perhaps led him astray at times. Thus not many zoologists will agree to the description of *Amoeba* as "a little lump of mucus come alive". Again, in describing the star-shaped 'Polaroid' filter as a demonstration of one of the possible ways in which the compound eye could mediate appreciation of the polarization characteristics of light reflected from the blue sky, the author seems in several places to imply that the individual ommatidia must actually be functioning in this way, and he nowhere alludes to the neurological problems which such a theory raises. For if each of the eight sensory cells which go to make up an ommatidium is in fact registering and passing separately to the brain the information it receives, a radical revision of some present concepts as to the mode of action of the sensory fibres will probably be necessary, and many of our present ideas about the compound eye may have to be revised. There are other similar points in the work which might be questioned. But in spite of such, the book is undoubtedly a masterpiece of condensation and simplification by a very great zoologist summarizing a life-time of research—research which has been largely instrumental in initiating a re-appraisal of some of the basic ideas about invertebrate sense organs and behaviour.

Von Frisch is very reticent about theory, and generally prefers that the facts should speak for themselves and that others should do the theorizing. Perhaps it is for this reason that the brief chapter on "Mental Capacity" is somewhat misleading. Here he states that no example of 'really intelligent action' by honey bees has ever been recorded; whereas what he means is that the ability to cope with new problems is strictly limited to certain situations only. Their ability to remember colour, odour and relative position of landmarks is extraordinary, and their powers of combining these memories and associating them with a given passage of time is even more remarkable. Every such combination learnt involves some perception of relations, and when a bee makes a detour around an obstacle and afterwards straightens its path as a result of experience it is showing, within strict limits, an insightful action. Moreover, the author supports his conclusions by citing lack of 'intelligence' in other insects; but to do this he merely quotes a story about a 'mason bee' and fails to cite much striking evidence to the contrary—not only with the mason bees *Eumenes* and *Rhynchium*, but also the far more conclusive and precise experimental studies of adaptive behaviour in the hunting wasps *Philanthus* and *Ammophila*. Indeed, his treatment of social and semi-social insects other than *Aphis mellifica* is too brief to be of much value, and is perhaps the least satisfactory chapter of the book.

But in spite of such shortcomings, it must be said that there are not many scientists of like eminence who could produce such a good popular book. Quite apart from its general educative and instructional value, it will, if it leads biologists as a whole to give more attention to simplicity and clarity in exposition, have a most valuable effect. W. H. THORPE

BLOOD GROUPS

Les groupes sanguins chez les animaux

Individualités sanguine et tissulaire. Par R. Dujarric de la Rivière et A. Eyquem. (Collection de l'Institut Pasteur.) Pp. 407+2 plates. (Paris: Éditions Médicales Flammarion, 1953.) 3,275 francs.

BLOOD-GROUP differences between individual goats were described by Ehrlich and Morgenroth in 1900 only a few months after Landsteiner's announcement of his discovery of the human blood groups. Ever since then, research on animal blood groups has continued and an enormous literature has been built up, scattered through very many journals and very varied in its methods and its aims, in contrast to the fairly well-integrated study of the human blood groups. Hitherto, almost the only comprehensive account of the subject has been a single excellent chapter in Wiener's "Blood Groups and Transfusion", so that a book bringing together the scattered threads has long been needed by workers in the field itself and in many related branches of science, especially, for purposes of comparison, by investigators of the human blood groups. That Dr. R. Dujarric de la Rivière and Dr. A. Eyquem have undertaken the task of reading and summarizing this vast literature entitles them to the gratitude of all such workers.

The title, "Les Groupes Sanguins chez les Animaux", as it appears on the outer cover, is supplemented on the title page by the words, "(Individualités sanguine et tissulaire)", and this extension of the subject to cover the whole of tissue immunity has involved the reading of another vast body of literature and has made the area covered so wide that no one or even two authors could possibly treat the whole of it critically.

Blood-group investigations require a knowledge both of serology and of genetics. The authors are primarily serologists, and the book is much sounder in its treatment of serology than of genetics. It is quite impossible for anyone to compress the whole of genetical theory, as the authors have attempted, into eighteen pages in a way that will be useful as an introduction to the genetics of the blood groups. To those without a knowledge of genetics such an account is inadequate; to those with the knowledge it is unnecessary.

Because the human blood groups have been more thoroughly investigated than those of any of the lower animals, an account of them is a necessary part of a book such as this; but it is the weakest part of the present book, containing numerous errors and statements of doubtful validity, especially on the genetical side. There is, for example, no evidence that (p. 64) the red cells of Lu^a Lu^a individuals are more strongly agglutinated than those of heterozygotes; and the tabulation of the Lewis genotype Le^b Le^b as corresponding to the phenotype Le (*a*–*b*–) (p. 65) is contrary to the facts.

Most readers will, however, turn at once to chapter 5 on the blood groups of various animal species. It is disappointing to find that this central subject of the book is dealt with in only 90 out of a total of more than 400 pages. Nevertheless, nearly every investigation of any importance is adequately, if not critically, described. Of particular interest are the accounts of antigenic differences between different breeds of certain animals, especially sheep. On the other hand, the more difficult genetical topics are not so well treated, and the profoundly interesting subject of the linkage groups in cattle and some other animals, their similarities to and differences from the human *Rh* system, deserves more space than it is given. There is a very good and comprehensive chapter on haemolytic disease of the newborn among animals which will greatly interest comparative pathologists.

More than a hundred pages are devoted to the subject of tissue antigens, cytotoxic antibodies, and tissue grafting. The treatment appears on the whole to be adequate, but the reviewer is only familiar with a small part of this extensive field. It is surprising that only about four pages are devoted to a subject of such great practical importance as skin grafting.

A very valuable feature of the book is an alphabetical bibliography of some eight hundred entries. A number of these have been checked—some minor spelling mistakes were found but no errors in dates, volume numbers or pages. The bibliography includes most of the papers of first importance, but a very considerable number of the works cited in the text are not included in the bibliography. Names, other than French, are very frequently misspelt in the text, but are mostly correct in the bibliography. There is a short but adequate general index.

Despite its faults, this book is an indispensable work of reference. It is most unlikely that in the near future anyone else will undertake the task of re-reading this immense literature. It is almost inevitable that in a few years a new edition will be needed. It is suggested that the authors should then omit the section (pp. 35–52) on general genetics, should call into collaboration a geneticist to ensure a more adequate treatment of the genetical and statistical aspects of the blood groups, should include in the bibliography references to all papers mentioned in the text, and should deal more fully with experimental skin grafting.

A. E. Mourant

ELECTRON MICROSCOPY AS A TEXT-BOOK SUBJECT

Introduction to Electron Microscopy

By Prof. Cecil E. Hall. (International Series in Pure and Applied Physics.) Pp. ix+451. (London: McGraw-Hill Publishing Company, 1953.) 64*s*. 6*d*.

THE final stage in the maturity of a branch of science or technology is the establishment of university lecture courses about it and the reduction of the sprawling, groping literature of its infancy to text-book form. By these standards electron microscopy has now come of age, as indeed the lapse of time since the invention of the first electron microscope would indicate. To gain entry to the McGraw-Hill International Series in Pure and Applied Physics adds the hallmark of respectability to a young and still somewhat revolutionary discipline.

The text now offered by Prof. C. E. Hall is based on his lectures to postgraduate students in biophysics at the Massachusetts Institute of Technology. It may be felt that it is much more detailed in its treatment of physical fundamentals than such a class would either understand readily or be likely to need in practising the subject. But the author has deliberately chosen such an approach, with an eye to probable future developments in the design of the instrument and in its operation. This is undoubtedly the wisest course to follow, although it will make the

text long and in parts heavy going for "science and engineering students with a background in physics and engineering at about the sophomore level".

That said, nothing but praise is due to this volume, both for its choice of material and for its presentation. The first two chapters form a résumé of fundamental physical theory, including an outline of wave mechanics, and the motion of electrons in electrostatic fields. The next three chapters discuss the ideal lens and then the practical electrostatic and magnetic lenses, the aberrations of which are dealt with in Chapter 6. The essential features of the electron microscope and its commercial realization are the subjects of Chapters 7 and 8. Chapter 9, one of the most valuable in the book, treats scattering phenomena as a prelude to the discussion of image formation in Chapter 10. The remaining two chapters deal thoroughly with the most important methods of specimen preparation and with typical examples of the applications of the electron microscope.

The text is marked by that clarity which follows from complete familiarity with a subject, and it is illustrated by plenty of excellent diagrams and photographs, remarkable even for this series; at a quick estimate there are some 350 figures, or nearly one per page. Most chapters are followed by problems to test the understanding of the student, and at the end it is a pleasure to find such full author and subject indexes. Although there is room, as in any new subject, for differences of opinion on the presentation of some points, such as the alignment of lenses, the book can be unreservedly recommended to all workers in the field, whether they be students or older practitioners; in fact, it is much more of a handbook than an introduction.

V. E. Cosslett

MAMMALIAN GERM CELLS

Mammalian Germ Cells

Edited by G. E. W. Wolstenholme, assisted by Margaret P. Cameron and Jessie S. Freeman. (A Ciba Foundation Symposium.) Pp. xvi+302+15 plates. (London: J. and A. Churchill, Ltd., 1953.) 30*s*. net.

THIS symposium conducted at the Ciba Foundation "for the promotion of international cooperation in medical and chemical research" has assembled thirteen papers concerned with the physiology of spermatozoa and eleven papers concerned with ova. It represents an attempt to bring together in a series of relatively brief presentations recent progress in these rapidly advancing fields. In addition to the formal papers, there is included the discussion of each by the various members of the symposium.

There can be no doubt that the general objective is attained. The various discussions of spermatozoa include analyses of the biochemistry of semen. In a number of instances attempts are made to correlate certain biochemical properties with practical problems in reproduction. For example, there is a critical review of aerobic metabolism in semen and its relationship to fertility in a paper by Dr. C. Terner. Again, Mr. J. C. N. Kok discusses the factors influencing the longevity of bull semen as used for artificial insemination. Of more interest to the physiologist and biochemist are the papers on the biochemical aspects of semen (by Dr. T. Mann), on factors controlling metabolic rates of mammalian spermatozoa (by Dr. H. A. Lardy) and on proteolytic enzymes in human semen (by Dr. F. Lundquist). A fascinating discussion on the movements of spermatozoa by Lord Rothschild reveals hitherto unsuspected hydromechanical relationships. The recent work on the preservation of spermatozoa at extremely low temperatures is informatively presented by Mr. C. Polge. The implications of this low-temperature work for the general problems of mammalian fertility and the preservation of desirable genetic characteristics are most fascinating. The practical implications of spermatozoology in human health and disease are ably presented by Dr. J. MacLeod.

Investigations of mammalian ova described in this volume are concerned with: (*a*) ovulation, (*b*) ovum maturation, (*c*) ovum transplantation, (*d*) *in vitro* studies with mammalian eggs, (*e*) early developmental physiology, and (*f*) medical problems relating chiefly to the ovum and pregnancy. As in the case of the spermatozoa, the problem of the longevity of the mammalian egg is touched upon in practically every phase of these investigations. This is especially apparent in the paper by Dr. S. A. Asdell on the effect of controlled ovulation upon the fertility of the mammalian egg, the paper by Dr. M. C. Chang on the fertilizability of rabbit germ cells and a paper by Dr. L. E. Casida on factors affecting fertilization and embryonic death. One of the chief mysteries relating to the development of the mammalian ovum is the problem of fertilization *in vitro*. This is discussed particularly in the paper by Mr. O. Venge, but forms part of the discussion of a number of the papers. The great difficulty experienced by a number of investigators in consistently effecting fertilization *in vitro* is emphasized. The experiments of Audrey U. Smith on the effects of low temperature on rabbit eggs signalize another field of experimentation which parallels similar work with spermatozoa. The transplantation of ova subjected to various experimental conditions is ably reviewed by Mr. C. E. Adams as well as by Dr. Chang. The clinical aspects are presented in papers by Dr. P. N. F. Bishop and Dr. Ian Donald.

It is, of course, not possible to present criticism of the numerous experimental details contained in this assemblage of papers. I find the presentation of sperm biochemistry comprehensive and adequate. The biochemistry of the egg is much less well established. For example, the knowledge of enzymatic transformations and the carbohydrate metabolism of sperm has no counterpart in ovum investigations. This may be due in part to the need for the development of adequate micro methods for use with the limited number of ova available for study. There is only tangential discussion of the role of hormones as regulators of sperm and ovum physiology. Although it is clear that some of the effects of the gonadal hormones may be indirect, nevertheless it would have been useful to have set forth their function in creating specific environments for spermatogenesis, ovulation, fertilization and early development.

There can be no question of the great usefulness of this volume to active investigators in the field of mammalian germ cells. It should be of fundamental interest also to persons interested in the problems basic to modern animal husbandry. Although in no sense a book for the medical practitioner, the thoughtful physician interested in problems of fertility and sterility should find this symposium informative and stimulating.

Gregory Pincus

Geometrical Mechanics and de Broglie Waves

By Prof. J. L. Synge. (Cambridge Monographs on Mechanics and Applied Mathematics.) Pp. vii+167. (Cambridge: At the University Press, 1954.) 25*s*. net.

GEOMETRICAL optics as well as Newtonian mechanics are based on the same variational principle $\delta \int v ds = 0$. In one case, v is the medium function; in the other, it is the velocity. Geometrical optics deals with rays and associated wave-surfaces. The same ray–wave relationship must, therefore, also be available for Newtonian mechanics. Starting with this important observation, Prof. J. L. Synge builds up the theory of "relativistic geometrical mechanics", in analogy with Hamilton's geometrical optics. Sources of light are replaced by space–time events, radiating world lines into the future; the wave-surfaces are three-dimensional surfaces in space–time—in fact, de Broglie waves, moving with a velocity which can be calculated from that of the associated ray.

If the concepts of wave-length, secondary waves, etc., are added semi-intuitively to the structure of geometrical optics, the resulting scheme (physical optics) suffices to give an adequate description of most optical phenomena. It provides easy solutions of problems where Maxwell's theory of electromagnetic waves would be difficult to apply. By analogy, Prof. Synge argues that a "primitive quantisation" of the scheme of relativistic geometrical mechanics (introduced by postulating that adjacent three-waves of equal phase are separated by a quantum of action h) would stand in the same relation to Schrödinger's wave mechanics as physical optics does to Maxwell's theory. A number of special cases are then discussed, among them the case of a particle in an electromagnetic field, and the case of the hydrogen atom.

Although one may wonder if Prof. Synge has not exhausted the possibilities of obtaining exact solutions, the novelty of his point of view is attractive and refreshing. The difficulty of the monograph comes from the relative unfamiliarity of the optical method of Hamilton, which had to be used, and the rather unfamiliar terminology. However, the effort of learning the new point of view is indeed very rewarding.

ABDUS SALAM

Three Abietaceous Cones from the Wealden of Belgium

(Mémoire No. 125 de l'Institut Royal des Sciences Naturelles de Belgique.) Par K. L. Alvin. Pp. 42+5 plates. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1953.)

IN this sumptuous monograph, a beginning is made to the detailed description and classification of some of the remarkably well-preserved fossil plants in the collections of the late Prof. C. Bommer, from Wealden clays in the Hainaut district of Belgium. The plants are preserved as a kind of lignite, in clay, and they have yielded to examination by microtome sections prepared by softening the material and then embedding in celloidin. In the cones here described, it has thus been possible to make a critical study of anatomical features, including the vascularization of the seed scales.

The three species of cones identified illustrate the importance and diversification attained by the family of the Abietaceae at this critical horizon in early Cretaceous times. The author reserves judgment on generic affinity and uses the form genus *Pityostrobus* Nathorst for all of them, having regard to the absence of information on associated vegetative characters. It has been possible, however, to define the species on a range of characters which is unusually wide for fossilized conifers. *P. andraei* (Coemans), a widely-spread species, and *P. bommeri* Alvin probably both represent extinct species of the genus *Pinus*; while *P. corneti* (Coemans), which is taxonomically perhaps the most interesting of the three, shares some characters with *Cedrus* and some with *Keteleeria*, and no doubt represents an extinct genus.

The continuation of such detailed studies of Cretaceous and of younger members of the Abietaceae should do much to elucidate the later evolution of this highly successful family, and thus add to the remarkable history of the Coniferales which has been placed on so well documented a basis by the work of Florin on the earlier members.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Edited by Charles C. Price. Vol. 33, 1953. Pp. vi+115. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 28*s*. net.

THIS issue maintains the reputation of the series by recording reliable practical details for a further selection of forty compounds, of varied nature and interest. Among them, creosol (2-methoxy-*p*-cresol) is obtained by treating an ethanolic solution of vanillin with amalgamated zinc and concentrated hydrochloric acid, the aldehyde group being reduced to methyl; dimethylketene distils over in 50 per cent yield as a solution in ethyl acetate when α-bromo*iso*butyryl bromide is added dropwise to boiling ethyl acetate and zinc turnings in an atmosphere of pure dry nitrogen under a pressure of 300 mm. mercury; and 9-fluorenecarboxylic acid results almost quantitatively when benzilic acid is stirred with pure benzene and anhydrous aluminium chloride. Other preparations include nicotinonitrile from nicotinamide; α-phenylcinnamic acid, and pure *cis*-stilbene therefrom; pyridine-N-oxide from pyridine and 40 per cent peracetic acid; and stearone from stearic acid. The cumulative index covers Vols. 30–33 of the series. An inserted leaflet directs attention to the explosive nature of the sodium salt of nitromalonaldehyde, mentioned in Vol. 32.

JOHN READ

The Year's Work in Librarianship

Volume 17, 1950. Edited for the Library Association by W. A. Munford. Pp. x+270. (London: Library Association, 1954.) 40*s*.

THIS is the last of a series of seventeen volumes, for it is considered that *Library Science Abstracts*, together with the projected "Five Years' Work in Librarianship", the first volume of which will cover the period 1951–55, will better meet the needs of librarians. Besides the usual book list, this final volume includes chapters on national and university libraries by A. C. Townsend, special libraries (B. C. Vickery), library co-operation (C. C. Adams), library buildings (E. F. Patterson), library practice (G. R. Davies, M. Piggott and W. C. Berwick Sayers), and subject bibliography (P. D. Record). As usual, the volume is well produced, and though the claim is justified that present needs will be better met in other ways, some will nevertheless regret the displacement of a convenient reference work which has proved its value.

THE PROBLEM OF THE TWO TYPES OF DIAMOND

By Prof. G. B. B. M. SUTHERLAND, F.R.S., D. E. BLACKWELL* and W. G. SIMERAL†

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Introduction

EXACTLY twenty years ago, Robertson, Fox and Martin[1] reported the existence of two types of diamond having marked differences in infra-red and ultra-violet absorption, in photoconductivity and in birefringence. Somewhat later, Raman and Nikalantan[2] reported that many diamonds had extra spots or streaks in their X-ray diffraction patterns. This observation was confirmed by Lonsdale and Smith[3], who reported that extra streaks were characteristic of type I diamonds and also that in general type II diamonds appear to be much more mosaic in structure than type I diamonds. The principal characteristics of the two types of diamond as determined from these early investigations are summarized in Table 1.

Table 1. Characteristic Features of the Two Types of Diamond

Physical property	Type I	Type II
Infra-red absorption	Bands at 4–5 μ Absorption 8–10 μ	Bands at 4–5 μ None between 8 and 10 μ
Ultra-violet absorption	Complete beyond 3000 A.	Transparent to 2250 A.
X-ray diffraction	Shows extra spots and streaks	Normal
Photo-conductivity	Poor	Good
Birefringence	Present	Absent

Afterwards, Sutherland and Willis[4] and also Ramanathan[5] showed that type I diamonds are not uniform in their infra-red absorption, since the extinction coefficient of the 8–10 μ band varies very widely from diamond to diamond. Thus the type II diamond may be regarded as a limiting case in which the value of the extinction coefficient of the 8–10 μ band has become vanishingly small. A similar gradation has been found in the position of the ultra-violet cut-off and in the intensity of the extra spots in the X-ray diffraction patterns. Thus, diamonds may be more satisfactorily classed as extreme type I, medium type I, weak type I and type II. It should be added that Blackwell and Sutherland[6] have reported two types of type II diamond neither of which exhibited any absorption in the 8–10 μ region but which showed differences in the 3–5 μ region.

No explanation for these anomalies in the physical properties of diamonds has yet been put forward which has received general acceptance. In an attempt to seek a satisfactory solution of this puzzling phenomenon, we have made an extensive investigation of the infra-red and ultra-violet spectra of a selection of diamonds. In a short paper giving an account of some of the early results[6], we suggested that the type II diamond was a normal pure diamond, whereas all type I diamonds had some impurity or imperfection in their structure which would account for the anomalies. The purpose of the present article is to present briefly the main results of our investigations with particular reference to the imperfection theory.

Type I and Type II Diamonds

First, however, it is necessary to consider a little more carefully the distinguishing features of type I and type II diamonds. Although any one of the properties listed in Table 1 has been generally accepted as a reliable guide in distinguishing type II from type I diamonds, the parallelism of all the physical properties is not at all satisfactory in classifying type I as 'extreme', 'medium', or 'weak', and occasionally a diamond classed as type II on the basis of one physical property would be classified as type I if one of the other properties were used. In a paper primarily concerned with possible correlations between the counting properties of diamonds and their crystal texture (as shown by divergent beam X-ray photographs) Grenville-Wells[7] has listed various physical properties of thirty-eight diamonds. Four of these diamonds had a cut-off in the ultra-violet below 2400 A., yet exhibited anomalous extra-strong X-ray streaks; thus by ultra-violet examination these four diamonds would have been classed as weak type I, but by X-ray streaks as medium or strong type I. Similarly, three diamonds which showed no extra streaks (and would therefore have been classified as type II) had their ultra-violet cut-off at wave-lengths longer than 2830 A. (indicating that they were medium or strong type I). Through the courtesy of Dr. Grenville-Wells, we have been able to examine the infra-red spectra of thirteen of these thirty-eight diamonds. We have found that in every case there is excellent correlation between the infra-red and ultra-violet method of classifying diamonds, but very poor correlation between the infra-red and X-ray method. In this connexion it should also be added that the observations of Grenville-Wells have shown that mosaic character cannot be reliably correlated with type II diamonds as originally suggested by Lonsdale[3].

There is therefore strong evidence that the same cause operates in producing the extra absorption found in the infra-red and ultra-violet spectra of all type I diamonds, but that additional factors may be the cause of the extra streaks and of the mosaic character found in the X-ray photographs of certain diamonds. In view of this, we propose to use a modified nomenclature in the future for the description of type I and type II diamonds. A diamond which is found to be type I (or type II) by spectroscopic means will be denoted by I*S* (or II*S*), whereas a diamond classified by X-ray methods will be denoted by I*X* (or II*X*). The spectroscopic symbol can be elaborated to read *Sir* or *Suv*, depending on whether infra-red or ultra-violet radiation was used in making the classification; similarly, the X-ray symbol should be modified to read *Xl* or *Xd* to indicate whether the diamond was classified by extra streaks on a Laue photograph or mosaic character as

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shown by a divergent-beam technique. Possible extensions of this notation by using combinations of the *S* and *X* symbols together with *e*, *m* and *w* to denote extreme, medium and weak are sufficiently obvious and need not be discussed here.

The distinctions just drawn between the various type I and type II diamonds are important in what follows, because in this communication we shall restrict our discussion to I*S* and II*S* diamonds. It appears to us that at least some of the confusion in the diamond problem can be eliminated in this way. In other words, there are several type I and type II diamond problems and we propose to start with the I*S* and II*S* types, since the classification by infra-red and ultra-violet absorption has been found (by the examination of several hundred stones) to give very consistent results.

We may begin by considering what would be predicted for the ultra-violet and infra-red spectra of diamond, assuming the Bragg structure and the current theories of molecular spectra.

Ultra-violet Absorption of an Ideal Diamond

From the examination of the ultra-violet spectra of large numbers of hydrocarbons, it has been found that only those hydrocarbons which contain a double or triple carbon–carbon bond exhibit absorption at wave-lengths longer than 2000 A. Since diamond presumably contains only single bonds, its ultra-violet cut-off might be expected to be below 2000 A. Since no II*S* diamonds have been found with a cut-off below 2200 A., it appears at first sight as if all diamonds are anomalous in their ultra-violet absorption, with II*S* less anomalous than I*S*. However, Klevens and Platt[8] in an investigation of the ultra-violet spectra of branched saturated hydrocarbons have shown that, as the degree of branching increases, the edge of the ultra-violet cut-off moves to longer wave-lengths; for example, from 1715 A. in *n*-pentane, to 1795 A. in 2,2,3,3-tetramethylpentane. One might, therefore, anticipate that diamond (which from this point of view resembles an extremely highly branched large hydrocarbon molecule) would have its ultra-violet cut-off in the neighbourhood of 2000 A. In order to test this hypothesis, we have examined the ultra-violet spectrum of adamantane ($C_{10}H_{16}$), which consists of four 'fused' *cyclo*hexane rings and which would yield diamond if it ever could be 'polymerized'. The ultra-violet cut-off of adamantane, while not as sharp as that of a II*S* diamond, is indeed very close to 2200 A. We should add that Herman[9] has recently made a theoretical calculation of the separation between the filled and unfilled electronic energy-levels of diamond and obtained a value of approximately 6 eV. This corresponds to an absorption edge of about 2050 A. We therefore conclude that the II*S* diamonds have perfectly normal ultra-violet absorption and that only the I*S* diamonds are anomalous.

Infra-red Absorption of an Ideal Diamond

From investigations on the infra-red absorption spectra of hydrocarbons, the force constants involving carbon–carbon bonds are sufficiently accurately known to make it certain that the fundamental frequency spectrum of the diamond lattice must extend from about 1,400 cm.$^{-1}$ (7·1 μ) to about 300 cm.$^{-1}$ (33 μ). The exact distribution of the normal modes over this range is a much more difficult problem, but calculations have been made by Smith[10] which give reasonable agreement with the observed second-order Raman spectrum, and her results can be regarded as a very good first approximation to the true distribution. It is necessary to consider next to what extent these frequencies may be expected to be active in absorption. Using the results of Teller[11] and Lifshitz[12], it can be shown that none of the fundamental frequencies should be active in absorption, but that combinations of fundamentals may give rise to absorption.

Now II*S* diamonds exhibit no absorption between 1,800 cm.$^{-1}$ and 100 cm.$^{-1}$ (that is, the fundamental region), but do have bands between 3,500 cm.$^{-1}$ and 1,800 cm.$^{-1}$ (that is, the region of combination frequencies). Thus II*S* diamonds are completely normal in their infra-red as well as their ultra-violet absorption.

Problem of the I*S* Diamonds

The conclusion that II*S* diamonds are perfectly normal in their optical absorption properties is an important one. The problem of the I*S* and II*S* types of diamond is now reduced to the problem of why I*S* diamonds show anomalous absorption. A few years ago, two of us suggested[6] that the extra absorption found in I*S* diamonds might be due to impurity centres in diamond. The exact nature of these was not specified. Impurity centres may consist of (1) foreign atoms, (2) missing carbon atoms, or (3) carbon atoms which are not in the same electronic state as the majority of carbon atoms in the diamond lattice. We may now consider what the effects of such impurity centres would be on the absorption spectrum of diamond.

(*a*) *Ultra-violet spectrum.* It is now well established that chemical impurities in silicon and germanium cause the edge of the main absorption band in these elements to move to longer wave-lengths[13]. Thus the shift of the absorption edge from 2250 A. in II*S* diamonds to 3000 A. (or even farther) in I*S* diamonds could be due to chemical impurities. The effect of missing carbon atoms on the ultra-violet spectrum is not so easy to predict; but, in general, lattice defects of this type may be expected to decrease the gap between the ground state and the lower edge of the first band of energy-levels. Thus the observations are probably also consistent with this second type of impurity centre. The third type of impurity centre might also be expected to cause a shift of the absorption edge to longer wave-lengths, but in addition might be expected to give rise to discrete lines superimposed on the continuous absorption. Such discrete lines are observed, and we have been able to prove that certain of these lines are closely correlated with certain infra-red absorption bands in the range below 1,800 cm.$^{-1}$ (cf. (2) below).

We may conclude that the extra absorption shown by I*S* diamonds in the ultra-violet can be readily accounted for in a qualitative manner by an impurity theory and that, of the three types of impurity centre considered, that arising from carbon atoms in an abnormal state seems the most probable.

(*b*) *Infra-red spectrum.* Anything which destroys the centre of symmetry midway between each neighbouring pair of carbon atoms in the ideal diamond lattice can cause absorption to occur in the region of fundamental frequencies. Thus any of the three varieties of impurity centre considered could conceivably account for absorption by I*S* diamonds in the region below 1,800 cm.$^{-1}$. Before discussing which

seems most probable, we shall summarize the most important results of our investigations on the infra-red spectra of IS diamonds.

(1) Absorption maxima of variable intensity have been found in IS diamonds at the following frequencies below 1,800 cm.$^{-1}$: 1,540, 1,520, 1,426, 1,372, 1,332, 1,282, 1,203, 1,171, 1,093, 1,003, 780, 480 and 328 cm.$^{-1}$. No absorption was found between 300 cm.$^{-1}$ and 100 cm.$^{-1}$. All but two of these bands appear to fall into two groups (as shown in Table 2) in the sense that the bands in each group always occur together and have the same relative intensity, but there is no correlation between the bands in the separate groups. The two maxima near 1,530 cm.$^{-1}$ have not so far been correlated with either group; but this may be due to the difficulty of making accurate intensity measurements on these weak bands. Many of the group *B* bands (for example, at 1,426, 1,372, 1,332 and 328 cm.$^{-1}$) are very sharp. All the group *A* bands are broad.

Table 2. Distribution of the Absorption Bands of IS Diamonds

Group *A* (cm.$^{-1}$)	Group *B* (cm.$^{-1}$)
1,282	1,426
1,203	1,372
1,093	1,332
480	1,171
	1,003
	780
	328

(2) It has been found that as the intensity of the group *A* bands increases, the cut-off wave-length in the ultra-violet moves to longer wave-lengths and the intensity of an ultra-violet line at 3157 A. increases. However, in IS diamonds containing group *B* bands, the intensity of this group of bands is independent of the position of the ultra-violet cut-off, but is correlated with the intensity of an ultra-violet absorption line at 4155 A.

(3) Following the methods of Smith[10], we have calculated the branches of the vibration spectrum of the diamond lattice and have been able to explain the high frequency ($> 1,800$ cm.$^{-1}$) bands of IS and IIS diamonds in terms of allowed combinations. The group *A* bands in the low-frequency ($< 1,800$ cm.$^{-1}$) spectrum of IS diamonds can also be accounted for in this way; but most of the group *B* bands cannot be associated with calculated maxima for the ideal diamond lattice.

(4) When IS diamonds are heated to 400° C., the only detectable change in the infra-red spectrum (between 4,000 and 700 cm.$^{-1}$) is a decrease of about 30 per cent in the intensity of the 1,372 cm.$^{-1}$ band. This band also moves to lower frequencies as the temperature increases, the temperature coefficient being 1 cm.$^{-1}$/50° C. Diamonds (IS and IIS), which had been heated to 1,700° C. and were re-examined at room temperature, showed no change in infra-red spectrum.

(5) The infra-red absorption bands of IS diamonds show no dichroic effects in regions where optical birefringence is observed.

(6) Irradiation of IIS diamonds by neutrons, deuterons and γ-rays has so far failed entirely to produce any of the absorption bands characteristic of IS diamonds. Neutron irradiation appears to give rise to the formation of graphite. Deuteron irradiation caused colour changes in the surface layers (green for a IIS and brown for a IS diamond).

(7) There is no correlation between variations in the ratio of carbon-13 to carbon-12 in diamonds and the intensity of the characteristic IS bands.

It is clear from the foregoing results that there is probably more than one cause for the appearance of anomalous absorption in IS diamonds, since the absorption bands fall into at least two classes which exhibit different properties. Moreover, part of the absorption can be confidently assigned to the activation of normally forbidden frequencies of the ideal diamond lattice; but some of the bands appear to be due either to chemical impurities or to carbon atoms in an abnormal state. Isotopic effects cannot account for the anomalous absorption. Since deuteron irradiation fails to convert a IIS into a IS diamond, it seems unlikely that vacant sites are the cause of the IS anomalies.

Conclusions

Our present conclusion is that carbon atoms in an abnormal state and chemical impurities probably both contribute in varying degrees to produce IS diamonds. If some carbon atoms exist in a state which enables them to form double bonds in IS diamonds, then the bands near 1,530 cm.$^{-1}$ could be due to the vibration of carbon–carbon double bonds in an unsymmetrical environment, and the movement of the ultra-violet absorption edge towards 3000 A. is consistent with the introduction of a few conjugated double bonds into the structure. Since graphite is a more stable form of carbon than diamond, it is tempting to consider that in IS diamonds some parts of the structure have gone part of the way towards graphite. However, the neutron irradiation experiments seem to produce graphite without giving the typical IS features as an intermediate stage. With regard to chemical impurities, it should be realized that there is very good spectroscopic evidence[14] for the presence of many impurities in the average diamond, and some evidence[14] (although much weaker) that IIS diamonds are less impure than IS diamonds. This is a point on which we hope to conduct further investigations. The appearance of some very narrow absorption bands in group *B* (which do not seem to belong to the diamond lattice) is most easily explained by attributing them to the presence of chemical impurities.

What does seem certain from these investigations is that type I diamonds (specifically IS diamonds) are imperfect. This is an unexpected result, since in our experience all large diamonds of gem-stone quality are always type I diamonds. While some very small type II diamonds are perfect octahedra, all the large type II diamonds which we have examined are very far from any of the ideal crystalline forms of diamond (octahedron, cube, etc.) and, in fact, usually exhibit a layered structure with highly irregular faces and fractured edges. It would almost appear as though a large single crystal having the ideal Bragg structure is unstable and requires certain impurity centres to be incorporated to give stability. The beneficial effect of impurities in the growing of large single crystals is well known to workers in that field[15].

A full account of this work is now being prepared for publication in a more appropriate journal.

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WORLD POPULATION CONFERENCE IN ROME

THE World Population Conference which met in Rome during August 31–September 10 of this year was financed jointly by the United Nations and some of its Specialized Agencies, by certain governments, and by private institutions and individuals through the International Union for the Scientific Study of Population. It was the first international conference on this subject to be attended by participants from all over the world since the Paris Conference of 1937. Some four hundred persons participated, each of whom had been invited by the Secretary-General of the United Nations in his private capacity. Even though many held official positions in their own countries, they did not in any way represent their governments, and the Conference confined itself to discussion, and adopted no resolutions. A number of participants attended from the Communist countries, but there was none from the Chinese mainland although invitations had been issued to a number of Chinese known to be interested in the study of population. Prof. Liebman Hersch, professor of demography in the University of Geneva and president of the International Union for the Scientific Study of Population, was elected chairman of the Conference.

Many papers were submitted to the Conference and discussed in thirty-one different meetings. They dealt with a wide variety of topics, ranging from narrowly demographic problems, such as the nature and quality of vital statistics or techniques of projecting population figures, to wide issues such as the probable future development of population in a number of areas and the relation of such population to the available resources. Some meetings were devoted to fields in which a number of disciplines overlapped: thus anthropologists and demographers discussed methods of measuring population-growth in pre-literate societies; a session was devoted to the discussion of population genetics, and in another the relations between intelligence and fertility were studied. One meeting under the chairmanship of Mrs. Alva Myrdal, of the Division of Social Sciences of the U.N. Educational, Scientific and Cultural Organization, concerned itself with the social aspects of population changes, with special reference to inter-disciplinary studies.

From the wealth of documentary material presented it is difficult to pick out individual contributions, and in the rest of this article I can only comment on a few of the topics that were discussed. It is hoped that the papers submitted to the Conference will be published in the not too distant future.

Population trends and the probable future course of population naturally formed one of the main interests of the Conference, and a number of meetings were devoted to the discussion of these subjects. Mortality and fertility were discussed separately, and different meetings were devoted to the areas of the West in which mortality and fertility are low, and to Africa and Asia where both are high. Finally, in a meeting presided over by Mr. Harold F. Dorn, of the United States, the general prospects for future population changes were discussed.

A good deal of statistical and other information is, of course, available about Western countries. In those areas changes in mortality are unlikely to exert a major influence on total numbers in the near future; the main difficulty here lies in the assessment of the probable future course of fertility. It was pointed out that, in the past, predictions of future population growth have by no means been conspicuously successful, and there was marked predisposition to abstain from detailed forecasts for the future. But there seemed to be some consensus of opinion that although the small-family system has come to stay, the very low fertility-rates experienced by Western countries in the immediate pre-war period were exceptional. It was believed that in the majority of Western countries future growth will be very slow and that the rate of natural increase will not be far from replacement. In spite of the relatively advanced level of statistical development in those areas, the need for further data and continued research into the social factors influencing fertility was stressed. In particular, the lack of comparability between studies in different countries was adversely commented upon.

The position is completely different in Asia and Africa, where in general both fertility and mortality continue to be high and where data are scarce. In those areas the development of mortality is more important in determining likely future growth than are developments in fertility. It was pointed out that, in many of these areas, public health and other ameliorative measures have been successful in greatly lowering mortality and that this process may be expected to continue in the near future. In some areas these reductions in mortality have been achieved without any marked improvements in the nutrition of the people and without any major changes in the economic or social structure. Such reductions will naturally raise the rate of population-growth, and the rise in turn may react back on fertility-rates. It was pointed out that there are large regions of the world—Latin America was mentioned as an example—where an increased rate of population-growth caused by lower mortality might actually increase national welfare; but it was recognized that in some countries which are already densely populated—India and Japan were cited as cases in point—unchecked population-growth would in all probability react adversely on the standard of living.

It became clear in the discussion that many of the governments of the Asian countries are fully alive to the dangers of population-growth and are encouraging research on these topics. Such research has the aim of providing better data to help in the understanding of these problems and also in devising measures which would help to slow down the rate of increase. A number of important and interesting communications described field-studies in population in progress in India, Indonesia, Burma and Japan and in some parts of Africa. The application of sampling techniques to demographic research in particular has proved very fruitful. In India, the government is encouraging research on methods of birth control, and also conducting a field-survey, with the technical assistance of the United Nations, on the efficacy of the 'rhythm' or 'safe-period' method of birth control as a check on population in some Indian villages. It was clear that in societies in which there is a high degree of illiteracy, the introduction of even the simplest methods of birth control would be fraught with difficulty, although there was considerable evidence of a latent demand for it on the part of parents who have already had three or more children.

In contrast there were Prof. Y. Koya's findings in Japan. There, the dissemination of contraceptive information in a number of fishing villages has had the effect of reducing the general fertility-rate in those areas by about one-third within a fairly short space of time. The population of Japan is, of course, more literate than that of India; but the success of the experiment astonished the Japanese themselves, who were surprised by the absence of a demand for large families which they thought implicit in the Japanese system of values. Interesting facts were also presented regarding the response to the recent Japanese law which has legalized abortion on socio-medical grounds. Recent Japanese experience was cited in support of the views of those participants who believe that increasing industrialization would *ipso facto* bring with it lowered fertility. It was made clear, however, that even if fertility in the Eastern countries were to decrease as a consequence of industrialization and economic progress, the present age-structures of those populations are such that in any event considerable increases may be expected in the near future.

A forecast of the U.N. Population Division for the population of the world as a whole estimated that by 1980 the figure would lie between 3,300 and 4,000 million people, against an estimate of 2,500 million in 1950. This estimate was put forward with all due caution. There are many areas of the world for which the data are still rudimentary, and if recent reports putting the population of China at 630 million prove correct, even the basic estimate for 1950 may be in error by as much as 7½ per cent. In spite of this, it was considered valuable to have an extrapolation of present trends in different areas prepared by an impartial and expert body like the United Nations.

A word or two may be said about the attitude of participants from Communist countries. The absence of Chinese demographers has already been commented upon and was keenly felt in view of recent reports in the Press on the results of the latest Chinese enumeration. It was clear that there are considerable differences between the points of view of the Communist demographers and their Western and Asiatic colleagues. The Communists regard continued population-growth as a sign of a healthy society and refuse to be perturbed by the prospect of continued pressure of population upon resources. In a communication to the Conference, Mr. Ryabushkin, of the U.S.S.R., wrote: "The Neo-Malthusians proposed to bring the number of population into conformity with the level of production. But an elementary logic suggests that on the contrary levels of production should be brought into conformity with the number of population, because it is production that exists for population, but not population for production. And that production can be repeatedly increased in a relatively short period of time is evident from the historical experience of the Soviet Union."

This point of view, which implicitly assumes that natural resources are unlimited, has in practice aligned the Communists with the Roman Catholic Church in their attitude towards birth control. Neo-Malthusianism is a term of abuse, contraception is discouraged and it is not clear to what extent contraceptives are made available to those who desire them on other than medical grounds. Maternity and child-welfare services are available to mothers and high fertility is encouraged. But it is by no means clear from the addresses delivered at the Conference to what extent the right of individuals to decide on the size of family that they would like to have is recognized in Communist countries.

In concluding, tribute should be paid to the success of the administrative arrangements for the Conference, which was held in the building of the Food and Agriculture Organization, and to the skill of the interpreters, who were successful in providing simultaneous translation of addresses which were frequently highly technical into English, French, Russian and Spanish. E. GREBENIK

POST OFFICE ENGINEERING RESEARCH STATION, DOLLIS HILL

OPEN DAY

THE Post Office Engineering Research Station, Dollis Hill, was open to visitors from the universities, industry and government departments on September 24, the Press having been invited the previous day. The functions of the Station, its staffing and its relationships with the telecommunications industry remain much the same as on the last open day (see *Nature*, **168**, 1022; 1951), though the buildings have since been increased, notably by one which provides a ground floor of nearly twenty thousand square feet devoted mainly to machine shops, an upper floor for drawing offices and part of another floor to a suite of laboratories devoted to thermionics. The individual problems being undertaken, whether basic studies or the development of new techniques or equipments to meet specific requirements, have, however, changed considerably, as the following descriptions of a few of the eighty exhibits presented will show.

The application of electronic techniques to telephone switching was shown in a private automatic branch exchange, devoid of electromechanical parts; it has an ultimate capacity of ninety-nine lines, exchange and extension, of which forty are now being connected. The switches use time–division–multiplex transmission, each line being allocated a fixed

position, of duration 1 μsec., in a continuously repeated cycle of 100 μsec., for the transmission and reception of speech currents. Registers and markers control the switches. The former receives the numerical information from the calling subscriber and stores it on gas discharge tubes before passing it to the marker which causes the called line to be tested and, if free, to be connected to the electronic equivalent of a cord circuit to which the calling line was joined when the call originated. A register is in service for as long as it takes a subscriber to dial, the marker for about 20 m.sec.

The Station has designed an electronic digital computer called MOSAIC and installed it at an establishment of the Ministry of Supply. The computer could be shown, therefore, only by way of photographs of key parts. It uses a pulse repetition frequency of about 600 kc./s.; storage is in ultrasonic delay lines with a full capacity of 1,030 words (instructions) and numbers, each of 40 bits, that is, each number corresponds to twelve digits in the scale of ten. A four-address system is used: each instruction to the machine defines the location of the two numbers to take part in the next arithmetical step, the destination of the answer and the location of the next instruction. The instructions and the numbers to be operated on are fed in, and the answers fed out, on punched cards.

Recently new attempts have been made to extract the essential information in speech in such a way as to enable it to be conveyed over a channel of bandwidth much less than that conventionally used in telephony ($\sim$ 3,000 c./s.). It is well known that speech can be synthesized sufficiently well by using only six slowly varying parameters—the level and pitch of the larynx tone, the level of hiss excitation and the frequencies of the three major resonances (formants) in the vocal tract—but until now it had not been possible to extract the last three instantaneously from speech. Progress was demonstrated, however, with equipment which sets up a spectral display differentiated with respect to frequency to find the resonances. The display is followed by circuits which generate the control signals of a synthesizer. The six signals may require a total bandwidth of only 180 c./s., to which must be added, however, that required by the filter designer to ensure satisfactory assembly and separation.

Transistors have yet to make any impact on the telegraph and telephone systems in Great Britain, but some simple line amplifiers and a quartz-controlled oscillator using germanium junction transistors showed some of the advantages of small size and power consumption which may later be obtainable. The great and almost immediate susceptibility of fully exposed germanium junction diodes and triodes to water vapour at room temperature and at a pressure of about 1 cm. of mercury was demonstrated; the maximum voltage which the diode or the collector-base junction could sustain fell drastically—recovering equally rapidly on sudden lowering of the vapour pressure to below 1 mm. For reliability, therefore, water vapour must not be allowed access to the active element.

Two new pieces of spectrographic equipment were on show. A compact source unit can produce a d.c. arc, a high-voltage spark and some triggered arcs, and a projector-comparator enables spectra on one or two plates to be seen and compared at a magnification of twenty times for the purposes of identification and semi-quantitative analysis.

Magnetic materials, so widely used in telecommunications, have been the subject of several developments. Nickel–iron strip as thin as 0·00015 in. has been rolled by a novel technique; its low-field permeability can be as high as 20,000 and its coercive force as low as 0·025 oersted after suitable treatment; thicker material (for example, 0·002 in.), similarly treated, can have values of 75,000 and 0·0075 oersted.

Repeaters (amplifiers) for inclusion in submarine cables have engaged more and more attention since 1945 (the first one was laid by the British Post Office in the Irish Sea in 1943) and have continually thrown up new problems as submarine schemes became more ambitious. The practical solutions to some, such as that of making the gland between cable and repeater capable of preventing the entry of water at the pressures encountered at depths of a mile or two and that of making reliable all the components (the failure of any one of which could, without other safeguards, involve a cable ship in many days of work) often entail meticulous attention to detail with no spectacular results; they are, however, being obtained. Ingenuity in the electrical design of the amplifier has eased some of the problems. Much improved accuracy in the measurement of the electrical properties of submarine cables has been necessary to engineer some of the longer systems; when obtained, it has brought to light new effects affecting the properties. Progress towards an oxide-cathode valve of high performance and long life (perhaps twenty years) has been made using a passive platinum core, the fundamental behaviour of which is becoming understood, rather than the active nickel core so widely used in commercial valves. Careful attention must be continuously given to pre-processing, assembly and vacuum techniques.

British deep-sea repeaters, though still housed in rigid cases, are streamlined and more easily handled during laying than the earlier shallow-water types. Telemetering devices fitted within a dummy repeater, for measuring shocks, spin, inclination and pressure, have been developed in order to investigate the conditions encountered between the time a repeater enters the water and when it finally settles on the sea bed.

The Post Office continues to give much attention to the methods of producing quartz resonators; the Essen rings which the Post Office has recently supplied as standards to the Greenwich, Ottawa and Naval (Washington, D.C.) Observatories and to the National Physical Laboratory (Teddington), the National Research Council of Canada (Ottawa) and the National Bureau of Standards (Washington, D.C.) illustrate some of the newer techniques. The quartz is now cut by an annular saw which reduces waste and surface damage and permits thinner wafers to be specified.

Quartz continues to play a part in narrow-band filters. At the same time, coil-condenser filters, so widespread in multi-channel telephony, still find new uses in radio engineering. The output stages of a radio transmitter generate harmonics which, if the fundamental frequency is up to, say, 20 Mc./s., may interfere with the local reception of television, particularly in fringe areas; a low-pass coil-condenser filter capable of dissipating that fraction of the transmitter power at the fundamental frequency which it absorbs (perhaps 0·3 per cent or up to 50 W.), inserted between the output stage and the

aerial, can sufficiently attenuate the harmonics. Filters play an increasing part in multi-channel microwave systems; Darlington's and Cocci's methods of network synthesis are being successfully applied to designs involving irises and posts in rectangular wave-guides.

The transmission of telephony and television at microwave frequencies could not be successfully undertaken without precision measuring equipment. Group-delay distortion of a frequency-modulated multi-channel telephony system results in intermodulation products of which little can be tolerated. The distortion introduced by filters, travelling-wave tube amplifiers and other components, over a bandwidth of 50 Mc./s. centred at about 4,000 Mc./s., can now be displayed on a cathode-ray tube with a sensitivity of 1 cm./μsec.

Equipment for long-distance radio communication in the 4–30 Mc./s. band is judged in part by its ability to combat the fading and multipath effects characteristic of ionospheric propagation. Because testing in service is slow and inconvenient, a fading machine simulating the natural effects is a great asset. An early machine, producing frequency-selective fading by combining two or three differently delayed signals of constant amplitude, but varying relative phase, has recently been modified so that the differently delayed signals individually fade in a near-random way, more closely simulating field conditions.

NEWS and VIEWS

Nobel Prize in Physics: Prof. Max Born, F.R.S.

Prof. Max Born, who has been awarded a share of the Nobel Prize in Physics for 1954, is known for many contributions to modern theoretical physics, particularly to the development of quantum mechanics and to the theory of crystals. The work mentioned specifically in the announcement of the Nobel award is the interpretation of the wave functions as probabilities for the positions of particles, a vital step in the development of the modern view of the relations between particle and wave aspects of atomic theory. This dates from a period when, in collaboration with Heisenberg and others, Born took an important part in the development of quantum mechanics, which form one of the two independent approaches to modern quantum theory. Other important work of that period, which has become classical, includes his use of perturbation theory for scattering problems and the Born–Oppenheimer theory of molecules. The theory of crystal lattices has formed another continuing interest, from the earliest papers which showed the basic ideas of lattice vibrations and their relation to the interatomic forces, to several treatises covering all aspects of the theory. Born has also taken an active interest in many other aspects of quantum theory. His effect on theoretical physics should, however, be measured not only by his own papers, numerous as they are, but also by the work of his pupils. His school at Göttingen was for a long time one of the most important centres to which young theoreticians went to find guidance and inspiration and to be infected with that enthusiasm and optimism which characterize Born's own work. The men who worked with him later at Cambridge and Edinburgh also include many who have made their mark on modern physics.

Prof. W. Bothe

Prof. W. Bothe, of the University of Heidelberg, who shares the 1954 Nobel Prize in Physics with Prof. Born, is known for many important contributions to modern physics. The best known of these include his introduction of coincidence methods into counting techniques and the work in which, together with Geiger, he applied the coincidence method to the Compton effect and showed that the conservation laws are satisfied in each individual event and not merely on the average. This was fundamental for the interpretation of atomic processes. With Kohlhörster he applied coincidence methods to the study of cosmic rays and thus helped to establish the presence of penetrating charged particles. Later, in the course of systematic work on nuclear reactions, he discovered the unusual radiation, emitted by beryllium under α-particle bombardment, which was later identified as neutrons. Other fields in which he did pioneer work include the study of hard γ-rays and the nuclear photo-effect produced by such rays and the problems of multiple scattering of electrons and of neutrons. On problems of scattering he has not only done experimental work of great importance but has also made valuable contributions to the theory.

Nobel Prize for Chemistry: Prof. Linus Pauling, For.Mem.R.S.

The Nobel Prize for Chemistry for 1954 has been awarded to Prof. Linus Pauling, of the California Institute of Technology. This award will be acclaimed by chemists of all kinds, for Prof. Pauling's contributions have brought about a revolution in the entire field of chemistry. His early work was concerned with the determination of crystal structures by X-ray crystallography, an interest which he has retained; his recent views on the constitution of proteins are based largely on detailed crystallographic analyses of amino-acids and peptides. The study of crystal structure led him to consider the nature of chemical bonds, and already in 1926 he published a remarkable paper on the structures of benzene and its analogues in terms of the Bohr atom. This, however, was soon followed by an impressive series of papers in which the new methods of wave mechanics were applied to chemical problems of all kinds, and in which the resonance theory was developed as a general qualitative approach to such problems. This work led to the recognition of additivity of bond energies and covalent radii in unconjugated molecules (that is, those with a unique classical structure), to the concept of resonance energy and intermediate bond character in conjugated molecules, and to the concept of electronegativity as a factor in determining covalent bond energies. Prof. Pauling's original tables of bond energies, covalent radii and electronegativities are still widely used, and later work has altered them only in detail. Many of these covalent radii were deduced from bond-lengths measured in his laboratory by the newly developed and difficult technique of electron diffraction. In recent years Prof. Pauling has made further notable contributions in fresh fields: a new theory of the metallic state, a theory

of immunochemical reactions, and new structures for polypeptides and proteins. Last but not least, he combines with all his other talents a remarkable gift of exposition; the impact of his work on the chemical world has been due largely to the brilliant lucidity of such treatises as "The Nature of the Chemical Bond".

Memorial Tablet to Sir William Herschel

On November 8 a memorial tablet was dedicated to Sir William Herschel in Westminster Abbey, not far from the graves of Newton and of Sir John Herschel, the son of Sir William. Newton had been buried in the Abbey in 1727, but it appears that at the time of Herschel's death in 1822 it had not been recognized that outstanding men of science should be buried there. From the epitaph on Herschel's grave at Slough, it is clear that his contemporaries realized that he had been one of the greatest astronomers of all time. He was known as the discoverer of the planet Uranus and of great numbers of double stars, star clusters and nebulæ. Some of these discoveries had been made when he was attempting to determine the distances of stars by their parallactic displacement; and although he had failed to determine the distance of any stars, he formed estimates which were not much in error. He had himself constructed telescopes of far greater power than any made by the instrument makers of that time for use in the national observatories, and the observations he made with these instruments made him the founder of sidereal astronomy on an observational basis. He was a pioneer in collecting and discussing astronomical statistics. He conceived our galaxy as the great flattened system it is. He determined the motion of the sun and planets through that system. He believed that some, at least, of the nebulæ might be island universes, that is, systems comparable with our own Milky Way but lying far beyond it. As there was no one with instruments comparable in light grasp with his, and no one with his great experience in observing, some of his ideas remained dormant until in the present century they could be taken up with the great Californian reflectors in combination with fast photographic plates.

The cost of the tablet in Westminster Abbey has been borne by Mr. J. E. Bullard, who had pointed out the absence of any memorial and the desirability of having one to the greatest of British observational astronomers. The service was conducted by the Dean of Westminster, Dr. A. C. Don, and an address on Herschel was given by Dr. J. Jackson, president of the Royal Astronomical Society.

Royal Society Medal Awards for 1954

The following awards of medals have been made by the President and the Council of the Royal Society:

Copley Medal to Sir Edmund Whittaker, emeritus professor of mathematics in the University of Edinburgh, for his distinguished contributions to both pure and applied mathematics and to theoretical physics.

Rumford Medal to Dr. C. R. Burch, of the H. H. Wills Physics Laboratory, University of Bristol, for his distinguished contributions to the technique for the production of high vacua and to the development of the reflecting microscope.

Davy Medal to Dr. J. W. Cook, principal of University College, Exeter, recently regius professor of chemistry in the University of Glasgow, for his distinguished fundamental investigations in organic chemistry.

Darwin Medal to Dr. E. B. Ford, reader in genetics, University of Oxford, for his distinguished contributions to the genetical theory of evolution by natural selection, particularly in natural populations.

Hughes Medal to Mr. Martin Ryle, lecturer in physics, University of Cambridge, for his distinguished and original experimental researches in radio astronomy.

Nature Conservancy: Scientific Research

In an adjournment debate in the House of Commons on October 22, Mr. Geoffrey de Freitas, one of the two members of Parliament who are themselves members of the Nature Conservancy, directed attention to the work of the Conservancy, particularly to research work being carried out and the importance of both adequate finance and public understanding if the work of the Conservancy is to be effective. With regard to research, Mr. de Freitas said that, in accordance with a suggestion of the Waverley Committee in its report on coastal flooding, the Nature Conservancy has again investigated the possibility of using vegetation to stabilize the shifting coast-line and, in co-operation with the Somerset River Board, is experimenting in this way in Bridgwater Bay. In co-operation with the Agricultural Research Council and other bodies, it is also examining the effect of spraying roadsides to kill weeds. So far as the Conservancy can judge, spraying has not proved effective in killing the most troublesome weeds, and it appears that indiscriminate spraying is doing real damage to insect life and small fauna. Before the outbreak of myxomatosis in Britain a year ago, the Conservancy asked Mr. R. M. Lockley to investigate the matter, and his survey of the problem, its repercussions and the progress of the disease has proved a valuable guide. Mr. Lockley has concluded that the rabbit flea is the most important transmitter, and work is still being done in studying the consequence of the drastic reduction in the rabbit population on vegetation and animal life.

Finance and Land Transference

Apart from finance and the bearing of public relations on the prosecution of fundamental research, Mr. de Freitas raised the question of the policy of land transference in connexion with the Conservancy. Replying on the debate, Mr. J. R. Bevins, parliamentary secretary to the Ministry of Works, promised to bring before the Chancellor of the Exchequer the question of land transference and the use of the National Land Fund for the Nature Conservancy. He pointed out, however, that the Conservancy already possesses powers of compulsory purchase under the National Parks and Access to the Countryside Act, 1949, but these powers have not been invoked and they are not to be used without the sanction of the Lord President of the Council. With regard to finance, the present annual expenditure of the Conservancy is about £200,000, and in this context Mr. Bevins stated that government expenditure on civil research is at the present of the order of £20,000,000 a year. Referring also to the ploughing up of sites of scientific interest, Mr. Bevins stated that the problems involved here are being discussed between the Nature Conservancy and the Ministry of Agriculture, and also with the National Farmers Union and the Council for the Preservation of Rural England.

Nuffield Foundation Support for Research in Rheumatism

DURING the past five years the Nuffield Foundation has been supporting much chemical and other work on adrenal hormones, but, with the gradual fading of the original hopes of cortisone and adrenocorticotrophic hormone as panaceas for the chronic rheumatic diseases, the Foundation is now reverting to its original policy of supporting fundamental and clinical research into the nature of the rheumatic diseases. As in the past, this programme will be supported both from the resources of the Oliver Bird Fund, which was created in 1948 by the gift of £450,000 from Captain Oliver Bird, and from the Foundation's original Nuffield endowment. Two large grants and two smaller ones are being made. The Foundation has made a grant of £70,000 to the University of Manchester, payable over the next eight years, to extend the work of the rheumatism centre under the director, Prof. J. H. Kellgren, professor of rheumatology in the University. This will be an addition to the original grant of £100,000, spread over ten years, which was made in 1946 to establish a pioneer centre in Manchester of the kind advocated by an expert medical advisory committee of the Ministry of Health at the end of the Second World War. For the past five years the Foundation has been supporting, with general grants for research staff, the clinical and fundamental work of the rheumatic unit directed by Dr. J. J. R. Duthie, senior lecturer in the Department of Medicine, University of Edinburgh. This unit, sponsored by the University to promote teaching and research in chronic rheumatism and to improve standards of treatment, was opened in the Northern General Hospital in October 1947. Limited accommodation has always been a handicap, and a new building is being erected on a site adjoining the unit's ward at the Northern General Hospital. This building, which will be associated with the name of Captain Oliver Bird, will have consulting and research rooms, clinics and laboratories. £27,000 has been given to meet the cost of the building and its furnishing, and in addition, the Foundation will continue its annual grant to assist the unit's work, £38,000 over the five years 1954–58 being provided for this purpose. The two smaller grants are as follows: £8,000 to the University of Sheffield to finance a research fellowship in the Sheffield Centre for the Investigation and Treatment of Rheumatic Diseases, directed by Dr. H. F. West; and £6,000 to the Oxford Regional Hospital Board for an experimental pathologist to work under Dr. A. G. S. Hill on the pathogenesis of rheumatic diseases at the Rheumatic Diseases Research Centre at Stoke Mandeville Hospital.

Hungarian Scientific Exchanges

IN September 1953, when the Hungarian Federation of Scientific and Technical Societies acted as host in Budapest at the Third Assembly of the World Federation of Scientific Workers, it was announced that it was intended that scientists from Western countries should be invited to Hungary in future years. This proposal was, in fact, carried out this year. Ten British and French scientists were invited to spend three weeks in Hungary, partly at the holiday resort on Lake Balaton and the rest of the time in visiting scientific institutes. Altogether, some one hundred and thirty individual visits were made, and every facility was given for the visitors to meet those working in their own fields of research. The visitors gave seventeen lectures to various sections of the Hungarian Federation. It is intended that invitations shall be extended to Hungarian scientists to visit Great Britain and France during the summer of 1955, so that the initiative of the Hungarian Federation in attempting to improve communication between scientists in the West and the East shall be followed up and, if possible, improved upon. Members of learned societies who might be interested in such exchanges should write to the Secretary-General of the World Federation of Scientific Workers, 15 Half Moon Street, London, W.1.

Rust Infection Studies

AN important study of the infectivity of single-spore strains, that is, physiological races, of the brown rust fungus (belonging to the group species *Puccinia dispersa*) to brome grasses, undertaken during a period of fourteen years, has now been reported on by J. Bean, P. W. Brian and F. T. Brooks (*Ann. Bot.*, N.S., **18**, 129; 1954). Each rust strain was maintained as a stock culture on a suitable host, kept permanently under 'Cellophane' covers to prevent contamination. The method of inoculation and techniques used to prevent cross-infection are described. By their infection reactions on a representative selection of *Bromus* spp. at least five physiological races have been characterized. Two of these have host-ranges confined to a single section of the genus, but others have a much wider host-range within the genus. The uredospore stage of all was identical. Studies of the teleutospores have been limited and knowledge of the species of rust involved is incomplete. All belong to the group-species *Puccinia dispersa* Erikss. and Henn.; the species *P. bromina* Erikss. and *P. symphytibromorum* Müller were included among the cultures studied, possibly also *P. bromi-maximi* Guyot. In a large series of inoculations, over a period of in all fourteen years, all physiological races have been remarkably stable in their infection types and host-range, and no confirmation of Marshall Ward's 'bridging-host' theory has been obtained. Cultivation of two physiological races for 164 generations on *Bromus arduennensis*, a species considered by Ward to have special significance as a bridging-host, induced no changes in their host-range.

Engineering Study of the Southern Californian Earthquakes

A DETAILED study of damage to buildings and other structures caused by the earthquake of July 21, 1952, has been published by the Seismological Society of America under the title of "An Engineering Study of the Southern Californian Earthquake of July 21, 1952, and its Aftershocks", by Karl V. Steinbrugge and Donald F. Moran (*Bull. Seis. Soc. Amer.*, **44**, No. 2*B*, 199 (April 1954). 2 dollars). The earthquakes, with the number of shocks shown in brackets, occurred on the following days: July 21 (7), 22 (2), 23 (3), 25 (3), 29 (2), 31 (1), and August 1 (1) and 22 (1), 1952. A further shock occurred on January 12, 1954. The epicentre of the first shock was at Wheeler Ridge, lat. 35° 00′ N., long. 119° 02′ W., and its magnitude was 7·6. The aftershocks, of lesser magnitude, were a little to the north and east of the first shock, in Kern County. The study includes sections on damage to structures, schools, dams, roads and bridges, and the earthquake effects on oil production and agriculture. Appendixes detail effects on particular buildings, such as Brock's

Department Store and Kern General Hospital. It is concluded that one- and two-story buildings, designed to resist earthquake forces, generally suffered no damage. No internal failures were found in wood diaphragms (straight or diagonally sheathed) or in steel diaphragms, although fastening details were deficient. Excessive deflexions of these diaphragms may have contributed to wall cracking, and contributed to failures along the diaphragm boundaries. The hazard to life of parapets on street fronts has been recognized. The use of competent technical help is necessary where earthquake resistance is desired; and if earthquake insurance is a factor, structures (in California) should be designed to meet the Pacific Fire Rating Bureau recommendations.

Scholarships for Personnel Management

An allocation to the Institute of Personnel Management from Counterpart Conditional Aid Funds has made it possible for the Institute to award a small number of scholarships designed to assist men and women, not less than twenty-four years of age, who are already in industry or commerce, to attend full-time courses of training in personnel management at one of the following: London School of Economics; College of Technology, Manchester; Glasgow and West of Scotland Commercial College and Royal Technical College (jointly); University College, Cardiff; and the University of Liverpool (post-graduate course in industrial sociology). The scholarships, which are tenable for one year, will amount to £300, with a dependants' allowance of £100 for a married candidate with one or more children and, in special circumstances, an additional grant not exceeding £50. Application forms, to be returned by January 31, can be obtained from the Secretary, Institute of Personnel Management, Management House, 8 Hill Street, London, W.1.

Geneva Laboratory of the Battelle Memorial Institute

On the occasion of the official opening on November 20 of a research laboratory in Geneva of the Battelle Memorial Institute, a symposium will be held on "The Influence of Scientific Research in the Modern World". The speakers at the symposium will be Prof. G. Colonnetti, president of the National Research Council of Italy; Prof. L. Jacqué, of the École Polytechnique, Paris; and M. Denis de Rougemont, director of the European Centre for Culture. A number of representatives of industry and finance in Belgium, France, Italy and Switzerland have been invited to participate at the symposium. On the same day the laboratory will be open for inspection. Further information can be obtained from the director of the laboratory at 7 Route de Drize, Genève-Carouge.

Precision Electrical Measurements: Symposium at Teddington

A symposium on precision electrical measurements will be held in the National Physical Laboratory, Teddington, during November 17–20, the last day being reserved for a visit to the Electricity Division of the Laboratory. The other days will be devoted to five sessions on the following topics (with the chairman shown in brackets): capacitance and dielectrics (Dr. L. Hartshorn); inductance and magnetics (Mr. B. G. Churcher); electrotechnics (Mr. R. S. J. Spilsbury); high-voltage measurements (Dr. L. G. Brazier); and high-voltage impulse-testing techniques (Mr. R. Davis). Further information can be obtained from the Director, National Physical Laboratory, Teddington, Middlesex.

Mineralogical Society: Officers and Council for 1954–55

The following have been elected officers and members of council for 1954–55 of the Mineralogical Society: *President*, Prof. L. Hawkes; *Vice-Presidents*, Dr. F. A. Bannister and Dr. F. Dixey; *Treasurer*, Prof. J. H. Taylor; *General Secretary*, Dr. G. F. Claringbull; *Foreign Secretary*, Dr. L. J. Spencer; *Editor of the Journal*, Dr. L. J. Spencer; *Ordinary Members of Council*, Mr. B. W. Anderson, Mr. S. H. U. Bowie, Mr. T. Deans, Prof. W. A. Deer, Prof. K. C. Dunham, Mr. P. M. Game, Dr. A. G. MacGregor, Dr. S. R. Nockolds, Dr. F. C. Phillips, Mr. L. A. A. Thomas, Dr. E. A. Vincent and Dr. M. K. Wells.

Italian Genetics Society

An Italian Genetics Society (Associazione Genetica Italiana) has been formed with the aim of uniting all Italian workers in genetics to further knowledge in this field. Officers for the current year are as follows: *President*, G. Montalenti; *Councillors*, C. Barigozzi, A. Buzzati-Traverso and A. Chiarugi; *Secretary-Treasurer*, G. Magni (Istituto di Genetica, Università di Pavia).

Announcements

The Duke of Edinburgh is to open officially the new laboratories of the Research Association of British Rubber Manufacturers at Shawbury, near Shrewsbury, on November 23.

The Franklin Medal of the Franklin Institute, Philadelphia, has been awarded to Dr. C. E. Kenneth Mees for his "contributions to knowledge of the photographic process and for his development of the first organized scientific laboratory in the United States which resulted in new products advancing the photographic process". The Medal is awarded annually "to those workers in physical science or technology, without regard to country, whose efforts . . . have done most to advance a knowledge of physical science or its applications".

The Royal Agricultural Society of England has decided to offer annually a medal together with an award of a hundred guineas for research work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. The award will be known as the R.A.S.E. Research Medal. Heads of university departments, research stations and institutes, and other research establishments should submit to the secretary, Royal Agricultural Society of England, 16 Bedford Square, London, W.C.1, in January of each year, the name of any member of their staff they may wish to recommend for the award. No direct applications by candidates will be considered.

Reference was made in *Nature* of September 25 to the position in the United States of Dr. J. R. Oppenheimer. We are informed that copies of the relevant documents are available from H.M. Stationery Office (York House, Kingsway, London, W.C.2, and provincial depots); they are the "Transcript" of the evidence (price 23*s.* 6*d.*; by post, 24*s.* 9*d.*) and "Documents and Letters" (price 2*s.* 3*d.*; by post, 2*s.* 6*d.*).

LIBRARY ASSOCIATION

ANNUAL MEETING

IN his presidential address to the Library Association on September 28, Mr. C. B. Oldman, principal keeper in the Department of Printed Books, British Museum, considered three or four general questions relating to the keeping of books. Are libraries, as at present organized, doing all that they should to ensure the preservation of recorded knowledge, as well as facilitating its dissemination ? Is the emphasis to-day too much on the supply of day-to-day requirements, including specialized information for the research worker ? Is the general, comprehensive library already outmoded, or should there continue to be at least one library aiming, as (in theory, at any rate) the British Museum Library at present does, at acquiring everything and keeping everything that it acquires ?

These are obviously questions bearing closely on the proposals for library reorganization that are implicit in the project for a Science Centre, and, although not limiting them specifically to science and technology, Mr. Oldman's remarks in the final section of his survey were concerned especially with the general research library, of which the British Museum is the acknowledged chief. Referring briefly to the functions of the specialist libraries, in stressing the importance of such libraries being able always to supply their users with the latest information, he perhaps overstressed the extent to which this permits such libraries to discard freely what was once important. Nevertheless, he correctly indicated the inadequacy of most such libraries for historical purposes, even in the field in which they specialize, and in pointing out that the term 'research' is often misapplied, for example, to hunting for information, he reminded his audience that science has no monopoly of research, if one defines research as original investigation involving the search for untapped or hitherto imperfectly appreciated sources and the drawing of new conclusions from what is found.

The discussion of the function of research libraries has so far not been very conclusive, and Mr. Oldman, in pointing out that what distinguishes the great research libraries is the large proportion of research material they contain, remarked that their strength derives from the extent as much as from the character or quality of their accumulations, and this is the root of the problem confronting them. If the great research libraries of the world continue to grow as they have in the past half-century, and if, while retaining all that has been already acquired, they are to endeavour to meet the new demands that are constantly being made upon them, with the multiplication of faculties and the springing up of new fields of study, they must face a prospect of infinite expansion, with all the problems of accommodation, staffing and finance involved. In the United States, in particular, they are beginning to wonder whether they will not be forced to call a halt. Mr. Fremont Ryder in 1944 estimated that, on an average, the American university library is doubling its stock every sixteen years, and in different degrees the same problem faces the whole group of general research libraries. So far as the British Museum is concerned, within a few years the present policy will lead to saturation point, and a new library on a new site will be required. Nevertheless, Mr. Oldman thought that completeness should remain the target and, when it is no longer possible to pursue the present policy, he suggested that it would be better to create separate subject libraries which will remain constituent parts of the one national library rather than to reduce current holdings or future intake. Such problems clearly demand close consideration in formulating plans for a national reference library for science and technology.

Several other papers presented at the conference were also of general interest to the scientific worker. Two papers read on September 30, for example, dealt with standards of service and the individual library and its place in the national system. In the first of these, Mr. J. H. Haiste, of Rugby, dealt with the question of standards and co-operation generally from the point of view of the library of the smallish authority, representing about a quarter of all library authorities in Great Britain. Mr. Haiste insisted that the service provided by such a library must be in harmony with the community it serves, but on the highest possible level for that community, and he thought that failure to adjust service to the conditions and needs of the community is mainly responsible for the failure of the library service in Britain to achieve its proper status. While fully recognizing the difficulties and disadvantages of the smaller library, Mr. Haiste thought that it should be less docile about its limitations : a cleaner, clearer scheme of co-operation would make for better standards of service, but the energy is derived from the individual libraries in each region able to do their own communal jobs first, and willing also to accept responsibility for providing on their own shelves a strong subject representation for the general benefit. He agreed with the Vollans's report that the most effective contribution the individual library can make to the success of library co-operation is to improve its own bookstock and its services to its own readers.

The second paper, by Mr. A. H. Chaplin, deputy keeper in the Department of Printed Books, British Museum, was concerned with the place and function of the British Museum. Describing the position of fundamental importance which the Museum occupies in building up a comprehensive national stock of books and the way in which the policy already indicated by Mr. Oldman is implemented, Mr. Chaplin, before he went on to consider the important contribution made by the Museum to the complete national bibliography, noted some classes of printed matter of potential historical interest which, although technically 'published', often failed to reach the Museum. There is, however, also need for a centre for co-operative work in supplementing the information contained in the original "Short Title Catalogue" of English books printed down to 1640, in Wing's list of English books published between 1640 and 1700 and in such lists as the "English Catalogue", relating to the nineteenth and twentieth centuries. Mr. Chaplin believes that the resources of the Museum and of a number of other important libraries could be both more economically and more effectively used if there were close co-ordination between them in their purchases of foreign books. The British Museum does not to-day attempt to cover systematically certain kinds of foreign publications, particularly

scientific and technical literature, but there is no certainty that the publications not taken by the British Museum will be found in some other British library, still less that, if acquired, they will be preserved. He suggested that the consultation and co-operation in this field already begun between the British Museum and other government libraries should be extended to the various national and university libraries and put on a systematic basis. Each library, while continuing to acquire the publications likely to be called for by its own readers, would undertake responsibility for acquiring, in particular fields to be allotted to it, the publications which, because of their obscurity or very restricted interest, are at present neglected. The British Museum, apart from developing more thoroughly its collections in the fields where it is already particularly strong, would acquire the books to which no one else is prepared to give house-room and would store those which every other library would prefer to discard. A natural corollary of such a system of co-ordination would be the making of a union catalogue of all the books to which it applies, giving at least one location for each book. In conclusion, Mr. Chaplin indicated the willingness of the Museum authorities, as part of any such projects, to make, after wide consultation, such changes in Museum practices as would bring them into harmony with the majority of co-operating libraries and remove present obstructions. Any such scheme, however, would require greatly increased resources in staff, in money and in buildings, and they will only be forthcoming if these demands are presented to Parliament backed effectively by influential opinion.

The place of the non-public library in the library system was considered by Mr. E. A. Baker, librarian in the Ministry of Food, in a paper also read on September 30. Stressing the need for greater co-operation between all types of libraries, Mr. Baker suggested that each public library participating in one of the subject specialization schemes recently set up in some of the regional bureaux should be able to look to a specialist library in its particular field for assistance in book selection and bibliographical information. He also suggested that the time has come for a thorough investigation into the constitution and organization of the Library Association with special reference to the representation of the non-public libraries.

Mr. W. B. Paton's paper on "Standards of Library Staff: Recruitment and Training", read on September 29, stressed the dependence for success of a library service on the quality of its staff. The general education of librarians should, he maintained, reach the standard at present demanded by the Library Association from examination candidates, and for preference should surpass it. This could be possible if the same rigid standards were not applied to the non-professional categories whose service is likely to be temporary. He also thought the division of staffs into professional and non-professional categories should become the declared policy of the Library Association as soon as possible, that university graduates should be welcomed as recruits to the library service and that in time this would be a normal standard of entrance. He urged that the time has come for the Library Association to reconsider its examination syllabus to relate it more closely to the needs of special libraries. He also suggested that the conduct of the examinations should be integrated with the activities of the schools of librarianship. The number of these schools should be reduced, but the qualifications of their teaching staffs should be raised and opportunity sought to link the schools with universities. A personal interpretation of the office of librarian, given by Mr. F. Raymond Smith, librarian of the Guildhall, on September 28, also stressed the importance of the professional ideal and discussed the closer adjustment of professional training to the needs of special libraries, and the related issues of the common structure and functions of both special and municipal libraries and librarians. On October 1, Mr. Bengt Hjelmqvist, head of the Library Board in Sweden, described the operation of public libraries in Sweden under fifty years of State aid.

FIFTH INTERNATIONAL SPECTROSCOPY COLLOQUIUM

THE fifth International Spectroscopy Colloquium, organized by Prof. F. X. Mayer, chairman of the Spectrochemistry and Colorimetry Group of the Austrian Society of Chemists, was held at Gmunden, Salzkammergut, Upper Austria, during August 30–September 3. More than five hundred members attended, representing twenty-three countries, and the importance to practical spectroscopy of these international gatherings is shown by the significant increase in the number of participants on each successive occasion. Two days were allotted to each of the principal sections—emission spectroscopy and molecular spectroscopy—with a mid-week excursion to the Nitrogen Works and Steel Works at Linz. The meetings were held at the Town Theatre, while a one-day symposium on direct-reading spectroscopy was held concurrently at the Kurhotel.

Emission spectroscopy. Three papers dealt with the analysis of silicates and silicate rocks and similar materials, for which various types of arc excitation are used. Progress in the detection of sulphur and halogens by high-current, low-voltage, short-duration spark discharges was reported, followed by studies of arcs and sparks in different atmospheres, highly reproducible 'sparking-off' phenomena and the stroboscopic examination of controlled sparks. A new atomizer using electrostatic spraying for flame analysis was described, and the use of amyl alcohol has been found to give a three-fold increase in accuracy and sensitivity in detecting calcium and magnesium.

Further studies of the Standard Paper Density Scale were discussed; improved results have been obtained with scale lines having a profile similar to that of spectrum lines. In determining the absolute error of photometric measurements, the use of polarization prisms is least open to objection, provided that the prisms are in perfect condition. Other subjects included errors in the 'method of additions', calibration with the rotating step-sector and devices for producing linear calibration graphs. Advances in equipment concerned microphotometers (one incorporating a recording electro-dynamic oscillograph, and the other an electric comptometer with a printing device), stigmatic grating spectrographs, and a plane grating in convergent light for the study of hyperfine structure and isotope shifts.

Direct-reading spectroscopy. A new universal quantometer and two British designs of the polychromator type (a grating instrument and an attachment to a quartz instrument) were described. Other

papers dealt with the analysis of aluminium alloys and steels, the use of the reflected image as an internal standard and a systematic study of iron + nickel + 1 per cent chromium and iron + cobalt + 1 per cent chromium alloys.

Molecular spectroscopy. Analytical applications of emission and absorption spectra in the vacuum ultra-violet were reviewed; photo-ionization of oxygen and other gases was reported in this region of the spectrum, and cross-sections have been calculated from intensity measurements. Other contributions dealt with the structure and composition of siliceous materials, the estimation of the insecticide parathion and the identification of components of fats and metal soaps.

A method of correcting ultra-violet spectra of macromolecules (proteins) for Tyndall or Rayleigh scattering was described. Changes of spectra with *p*H have been assigned to ionization of phenolic groups of tyrosin in albuminoids. The results given on double bonds in relation to the dependence of Raman line intensities on excitation frequency are not in accord with Placzek's theory. Vibration-rotation bands of C_2, CN, CH and CO in infra-red flame spectra and determinations of flame temperatures were discussed. Microwave data on deuterated derivatives indicate the exact structure of the pyridine molecule, and the effect of solvent and hydrogen bonding on the dipole moment of pyrrole is related to shifts in the NH frequency. Work on hydrogen bonding, particularly water in silica gels, was reviewed. It is concluded from infra-red studies of structure and intermolecular interactions of the amide group that dipole–dipole interaction rather than hydrogen bonding is the controlling factor in polyamide and polypeptide structures. Many overtone and combination bands have been identified in near infra-red spectra of polypeptides and proteins, using polarized radiation. Studies of the spectra of amorphous and crystalline celluloses, using the hydrogen–deuterium exchange, were reported, and the ultra-violet absorption of cellulose xanthogenate has been analysed by analogy with simpler organo-xanthates.

New designs of spectrophotometers and a partly mechanical, partly electronic, 'memory system' for converting a single-beam spectrometer to give percentage absorption traces were described. A punched-card system of documentation was demonstrated, and the 1954 Ohio State meeting was reviewed. In addition, three papers were presented on X-ray fluorescence spectroscopy.

The innovation of holding pre-arranged evening discussions proved successful, and it is hoped to extend this feature on future occasions. The four topics selected were: experiences with methods not requiring standards for comparison, using different techniques; the evaluation of spectrograms (in this discussion the desirability of international standardization of symbols, definitions and analytical methods was stressed and referred for action at the next Colloquium); a comparison of relative sensitivities of the eye, the photographic emulsion and electrical radiation receivers, in spectrophotometric work; and the equipment and technique of Raman spectroscopy—its analytical possibilities and scope in comparison with infra-red methods.

A somewhat fuller summary of the proceedings of the Colloquium, giving the authors and brief notes on the papers presented, is being published in a "Spectroscopic Conferences Supplement" to the forthcoming December issue (No. 14) of the *British Bulletin of Spectroscopy*. A complete record of the papers and discussions will be published in a special volume of *Microchimica Acta* (Springer-Verlag, Vienna) in 1955. Proposals for the Sixth Colloquium were discussed at a committee meeting attended by delegates from fourteen countries. Possible broadening of the scope to include the physics of spectra, with joint or consecutive meetings with other bodies, was considered. However, it was decided to continue the organization on lines similar to those of previous occasions, but with more emphasis on prearranged discussions on selected topics. It was finally agreed that the next Colloquium should be held in Holland in the autumn of 1956.

D. M. Smith

APPLIED RESEARCH IN TECHNICAL COLLEGES

A SPECIAL committee of the London and Home Counties Regional Advisory Council for Higher Technological Education has issued a report on applied research in technical colleges*, based on information supplied by seventeen out of the twenty-five colleges in the region approached by the committee. The Council is satisfied that the report covers substantially all the published research undertaken in technical colleges in the region during 1947–52, and some 330 original contributions to scientific or technological knowledge are listed in an appendix, the great majority being in physical, inorganic and, especially, organic chemistry. There is also some bias towards biology; but the Council comments that relatively few of the published researches in organic chemistry appear to have been undertaken in direct co-operation with industry.

An appended list of research projects undertaken at the direct request of industry indicates that technical colleges have helped and are helping in the investigation of engineering problems in circumstances in which no question of publication arises, and a further appendix gives examples of co-operation between technical colleges, research organizations and government departments, including the Department of Scientific and Industrial Research. The Council considers, however, that there is room for a considerable increase in the amount of work done in consultation with industry or for industry's direct benefit, and supports the view that one important function of technical colleges is to train research technologists for industry (especially, perhaps, for the engineering industry) and that fundamental research provides an admirable training in research methods. It suggests that here the technical colleges could be of particular assistance to the small firm, and that the investigations now in progress by part-time students, possibly working for a master's or a doctor's degree, represent a fruitful line of co-operation by which the resources of the colleges may, by agreement, be used by an individual nominated by a firm to conduct a relatively long-term investigation in which the firm is interested. An appendix to the report shows that during the period four doctorates in science, 105 Ph.D.s and 104 M.Sc. degrees of the University of London were awarded for research carried out in the technical colleges of the region.

* Applied Research in Technical Colleges. Pp. 44. (Publication No. 18.) (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1954.) 2*s.* 6*d.*

Since January 1950, about two dozen posts of research assistant or demonstrator have been approved in London and the home counties. Most of these have now been filled, and at about a dozen colleges research by staff and advanced students is accepted as a normal part of the curriculum. At other colleges, research by members of the staff is recorded and the report emphasizes that staff of the calibre required will never be attracted unless some opportunity for original research is provided. The close contact of the staff with neighbouring firms should avoid any difficulty in suggesting lines of investigation likely to be of service to local firms, nor should members of the staff necessarily be required to carry out such research on the college premises.

The evidence shows that departments of chemistry have usually found it easier to provide facilities for research than have departments of engineering, and that the principal obstacle to the further development of industrial research in many technical colleges, even the largest, is lack of laboratory space. This position is attributed partly to the simpler apparatus and less space required in chemical research than in engineering research, and partly also to the absence of sufficient workshop staff; and the Council recommends that the needs of the engineering industry should be kept in mind in allocating research demonstratorships. It also urges authorities to press forward especially with extension plans for those departments in which the standard of work shows that more research could be undertaken successfully in co-operation with industry. Commenting on the circumstances in which staff should be given relief from teaching duties, the Council sees no objection to lecturers undertaking consulting work, and would support *ad hoc* investigations in colleges by members of the staff which are not of the kind that normally lead to publication; it also stresses the importance of personal relations between the colleges and industry.

THE AMERICAN PHYSICAL SOCIETY

REPORT FOR 1953

THE 1954 annual meeting of the American Physical Society was held at Columbia University, New York City, during January 28–30, and the twenty-third annual meeting of the American Association of Physics Teachers was held simultaneously at Columbia University, Barnard College, and the City College of New York. At the joint ceremonial session of the two bodies on January 29, the retiring presidential address of the American Physical Society was delivered by Prof. E. Fermi, of the University of Chicago, who spoke on "What can we Learn with High-energy Accelerators?" The 1953 Oersted Medal of the American Association of Physics Teachers was presented to Prof. C. N. Wall, of the University of Minnesota (*Amer. J. Phys.*, **22**, 363; 1954). The twelfth Richtmyer Memorial Lecture was delivered by Prof. J. A. Wheeler, of Princeton University, who took as his subject "Fields and Particles". At the joint banquet which followed, the after-dinner speakers were Prof. Grayson Kirk, president of Columbia University, who discussed the position of physics in the social structure, Prof. Leon Brillouin, of International Business Machines Corporation, who spoke of Prof. H. A. Lorentz, and Prof. S. A. Korff, of New York University, who referred to the International Geophysical Year and recounted some of his experiences in a high-altitude laboratory in northern Alaska. The second O. E. Buckley Solid-State Physics Prize was presented to Dr. J. Bardeen, of the University of Illinois, for his outstanding contributions to semiconductor research.

At the business meeting of the Society it was reported that the total membership had reached 11,200, the financial position was satisfactory and that the *Physical Review* continued to expand. The following were elected to hold office for 1954: *President*, H. A. Bethe; *Vice-President*, R. T. Birge; *Secretary*, K. K. Darrow; and *Treasurer*, G. B. Pegram. The annual meeting was again a very large one, with a registration of 2,100 and with more than three hundred contributed papers. Columbia University, which has been host to the Society on many occasions during the past fifty years and in particular for eleven of the past twelve annual meetings, has now reluctantly admitted that such a large convention involves too great a burden, and accordingly it has been agreed to hold the 1955 annual meeting in hotels in the vicinity of Pennsylvania Station, New York City. As a valedictory to Columbia University and as a tribute, which was made doubly fitting by the fact that 1954 is the bicentennial year of the University, a special session of the annual meeting was devoted to a survey of the University's association with physics and with the American Physical Society. This consisted of four addresses and the presentation of a plaque, to be affixed to a wall in the Pupin Physics Laboratories, commemorating the Society's inaugural meeting on May 20, 1899, at Columbia University. Prof. G. B. Pegram reviewed the early years in the history of physics at the University, Prof. E. Fermi the genesis of the nuclear-energy project, Prof. I. I. Rabi the more recent years, and Dr. K. K. Darrow, the Society's secretary, discussed the link between the Society and the University.

The scientific programme of the Physical Society meeting, details of which together with abstracts of the contributed papers are given in the minutes of the meeting (*Phys. Rev.*, **94**, 742; 1954), included a joint session of the Division of Fluid Dynamics and the Institute of the Aeronautical Sciences, at which four papers dealing with high-speed flow phenomena were read; four symposia; a group of four papers in which plans for accelerators of the future, including the designs of the 25-BeV. proton synchrotron for CERN and a 15-BeV. accelerator, were discussed by E. D. Courant, J. P. Blewett, M. S. Livingston and H. G. White; and nineteen invited papers. At the Brookhaven–Nevis symposium the subjects of discussion were the use of the cosmotron as a research tool and the interpretation of high-energy experiments; at the symposium of the Division of Fluid Dynamics there were four papers dealing with aspects of shock waves in liquids and solids; at the symposium of the Division of Electron Physics the conduction mechanism, interface compound formation and noise mechanisms in oxide-coated cathodes together with a review of electronic processes in barium oxide crystals were considered; and at the separate symposium devoted to the subject of nuclear size and density of distribution four differ-

ent methods of determination were described. Of the invited papers, two, by members of the Bell Telephone Laboratories, dealt with the theory of secondary electrons; two, including a discussion by J. R. Zacharias of precision measurements, with molecular beams; two with the neutrino; three, "Microwave Resonance in Colour Centres", by E. E. Schneider, of the University of Durham, "Polarization of Nuclei in Metals by Magnetic Resonance", by A. W. Overhauser, and "The Solid-State Cyclotron", by C. Kittel, with magnetic resonance; and two with cryogenics. In addition, P. W. Bridgman spoke of the effects of pressure on twelve rare-earth metals, W. A. Pomerantz on cosmic radiation at very high altitudes near the geomagnetic equator, and E. W. Corson on the properties of new V-particles.

The programme of the meeting of the American Association of Physics Teachers (*Amer. J. Phys.*, **22**, 426; 1954) consisted of two panel and one round-table discussions, three invited papers, twenty-seven contributed papers, a film session and a business meeting in addition to the joint sessions with the Physical Society. C. N. Hoyler, of the Radio Corporation of America, gave a demonstration of colour television in which recent developments of the R.C.A. were described and illustrated. In the panel discussion on "Research Subsidies and College Teaching", various problems involved in combining teaching and research were considered; and in the session devoted to a discussion of the functions and mission of the Association, H. K. Schilling reviewed the history of the Association and T. H. Osgood, editor of the *American Journal of Physics*, spoke on "What goes into the Journal". At the business meeting of the Association on January 30, it was agreed to confer honorary membership on D. Bronk, former president of Johns Hopkins University, president of the National Research Council and head of the Rockefeller Institute for Medical Research; and for noteworthy service to the Association T. D. Cope, P. Kirkpatrick, C. J. Overbeck and M. H. Trytten were voted special citations. The need for increased income to cover current expenses was emphasized and a change in the by-laws was approved to permit the increase of subscriptions to a maximum of eight dollars per annum. The following were elected to hold office for 1954: *President*, P. M. Marsh; *President-elect*, R. R. Palmer; *Treasurer*, F. W. Sears; and *Secretary*, R. F. Paton.

BREEDING FOR BEEF IN TROPICAL AND SUB-TROPICAL CLIMATES

CLIMATE, and temperature in particular, is directly concerned with the success or failure of animal production in tropical and sub-tropical territories. It has been established in various parts of the world that wide variations exist between different breeds and types of farm animals in their ability to adapt themselves to the climatic conditions peculiar to a particular environment. Because of their low powers of adaptability, the introduction of European breeds has failed in most tropical territories, and this has focused the attention of research workers on the wide range of ecological problems confronting the livestock industry in those parts of the world (D. M. Joubert, *Colonial Plant and Animal Products*, **4**, No. 1; 1954).

In the breeding of livestock for tropical and sub-tropical environments, it is important to pay attention to the conformational features and breed characteristics which promote adaptability. First, for maximum radiation to be possible, the animal must possess a large skin area. It is a noticeable feature of cattle native to tropical regions that they have a well-developed dewlap which extends down to the navel, together with easily extensible skin folds which are especially numerous in the neck and thoracic regions. These characters are illustrated in the Afrikaner bull and cow, a tropical breed indigenous to South Africa and belonging to the lateral-horned zebu group. In the zebu cattle of India the ears, too, are considerably larger than those of *Bos taurus* (European) cattle.

Hair covering, which includes the thickness of the coat and structure of the hair fibre, is of equal importance in heat regulation. The critical temperature of smooth-coated cattle lies several degrees below that of woolly-coated individuals. In recent investigations, Bonsma and his associates have showed that, with the progeny of a mutant woolly-coated Afrikaner bull, tropical degeneration is possible also in the native stock should they lack any of the essential attributes which promote adaptability.

Earlier studies showed that a light-coloured coat is superior to black in the dry tropics. White or cream-coloured individuals do even better than reds provided that the hide is protected by pigmentation. Colour is regarded as playing a part in heat regulation by influencing the amount of sunlight that is reflected from the skin. Dark colours presumably tend to increase the heat load of the animal. Measurements of the reflexion of light from various coat colours indicate that the coat of white Afrikaners absorbs about 45 per cent of the solar radiation impinging upon it, as against 89 per cent in the case of the black hairy coat of Aberdeen–Angus cattle, 78 per cent of red Afrikaners, 93 per cent of red Sussex cattle and 50 per cent of cream-coloured Simmenthalers.

The effect of a tropical environment on the conformation of an unadapted beast is shown by comparing an unadapted woolly-coated Shorthorn cow with a normal individual of similar breeding and age. Whereas the beef Shorthorn is normally a digestive type—that is, relatively round in cross-section and equally deep through both chest and belly—the exotic animal in tropical environments tends to develop into a respiratory type. This may be explained by the fact that the Shorthorn has a limited skin area and also a woolly coat, both lowering its capacity of heat loss. The burden of thermolysis thus falls almost entirely on the water-evaporating capacity of the lungs, and the obvious conformational change to take place is an increased lateral depth of chest, flattening of ribs and a contracted belly.

Joubert has also considered the effects of the nutritional environment on cattle in tropical countries. In regions with fluctuations in the nutritive value of the natural pastures, as well as with high summer temperatures, the problem of adapting the exotic beast is complicated. As the body temperature increases during the hot months, metabolism is stepped up, the time spent in grazing is reduced and that of lying in the shade increased. In short, the animal suffers from a constant fever or hyperthermia. If the grazing is exceptionally

poor, it is quite impossible for the leeway to be made up during the period of the year when temperate cattle are not affected by the climatic conditions. In the case of the animal surviving, it virtually exists in a state of chronic undernourishment.

Although animal breeding still presents many problems, both genetical and physiological, the knowledge gained from scientific approaches to the subject during the past three decades has made it considerably more exact and practicable. Scientific investigations provide the evidence to prove that the high-grade European breeds of cattle, which are the result of selection for maximum performance under temperate climatic conditions, do not maintain the same qualities when transferred beyond the borders of their natural habitat or of regions with approximately similar conditions. Hence, improvement of animal production by merely replacing the cattle native to tropical and sub-tropical regions with highly improved breeds of temperate origin is out of the question.

The genetical variation occurring within the exotic breeds makes possible the selection of individuals possessing those attributes required for increased adaptability to tropical conditions. By basing their selection on such characters as coat covering and colour, Bonsma and his associates have achieved considerable success in increasing the heat tolerance of British beef breeds, especially Herefords, at the Mara Research Station, which is situated in the dry-tropical zone of South Africa. The limit of such a policy is indicated, however, by the fact that when these investigations were repeated at the Messina Experimental Farm, situated in a lower-lying tropical belt, they met with complete failure. The high mortality-rate of the British beef breeds in the tropics, compared with the indigenous stock, also seriously limits the value of breeding adapted strains of European cattle.

Cross-breeding between the indigenous stock and exotic types presents a second possibility. During the early stages of livestock improvement in tropical regions, a policy of grading up with European breed bulls was advocated. The first generation cross-breds excelled because of hybrid vigour and the genetical dominance of heat-tolerant characters; as the percentage of indigenous blood diminished in subsequent generations, the cross-breds also deteriorated.

The most constructive and successful of all long-term policies for livestock breeding in tropical and sub-tropical regions seems to lie in improvement of the indigenous stock by means of judicious selection. The high standard of animal production of temperate countries can never be attained in tropical regions, while the indigenous stock of the tropics are inherently of lower productivity than their cousins of the temperate zone. Nevertheless, in the Afrikaner, it has been demonstrated that improvement of beef qualities is possible without any loss of those characters which give the breed superiority over exotic types in the tropics and sub-tropics. As for its slower growth and maturing characters, these actually are inherent qualities of practical significance and value in the production of beef under varying conditions of climate, and especially nutrition. As a result of a slower growth-rate, the influence of periodic nutritional depressions is not so acute as is the case with the rapidly growing, early-maturing breeds of beef cattle.

LIBRARY CO-OPERATION IN BRITAIN

THE final recommendations on Library Co-operation of the Joint Working Party set up by the National Central Library and the National Committee on Regional Library Co-operation have now been issued in the name of the Library and the National Committee*. The working party was satisfied that the general structure of library co-operation and inter-lending is sound, and recommended that university and special libraries outside the area covered by the London Union Catalogue and the South Eastern Region should become participant members of their appropriate regional system on the basis on which many of them at present co-operate, and that they should also retain the existing right to send applications direct to the National Central Library. Within this area, however, it recommends that, as at present, university libraries should apply direct to the National Central Library for inter-library loans, but special libraries should have direct relations with the Central Library; and that membership of the London and South Eastern Regional Library systems should remain restricted to the public library authorities within the area.

The working party is also satisfied that the Union Catalogue is necessary for effective inter-lending, and recommends that the existing Union Catalogue should be brought up to date. The Yorkshire, North Western and West Midland Regions should consider how best they may provide Union Catalogues of stock prior to a specified date, which would be adequate for regional and national purposes, and from that date all regional union catalogues should contain entries for British books, and for all other books published outside Great Britain, and those published in Great Britain prior to the specified date. The working party also recommends that each region should consider what co-operative arrangements could be made to ensure that all applications to the bureaux for current British material are supplied from resources within the region, and to ensure that at least one copy of every non-fiction book in the region is retained permanently in that region. Each region should also investigate the methods by which the range of periodicals can be improved and their permanent preservation ensured.

The working party recommends the exclusion from the scope of all inter-lending agencies of: (*a*) those works of English and American fiction outside the scope of the joint fiction reserves to be set up in the various regions; (*b*) sets of copies of plays for acting and reading outside the scope of any joint play collections to be set up in the regions; (*c*) children's books; (*d*) 'quick reference' books (that is, dictionaries, atlases, encyclopædias, etc., likely to be regularly consulted in a library); (*e*) current year-books, annuals and directories; (*f*) current numbers of periodicals.

It also suggests that all books in print costing 25*s*. or less should be outside the scope of the National Central Library.

The working party considers that any long-term plans for bringing these regional bureaux to a state of greater efficiency and maintaining them adequately

* Recommendations on Library Co-operation. Pp. 8. (London: National Central Library and National Committee on Regional Library Co-operation, 1954.)

should attract a grant from H.M. Treasury. It is indicated that the National Central Library proposes to institute, in consultation with the National Institute of Adult Education and the other bodies concerned, an inquiry into the present provision of books for adult education classes, with the view of considering how far the type and the extent of the services require modification.

THE FILM AND THE SOCIAL SCIENCES

ALTHOUGH film processes are being increasingly used for research in the physical and biological sciences, little attention is paid to the cinema as a medium for investigating, teaching and propagating new knowledge in the social sciences (*Science and Film*, **3**, No. 2; June 1954). This may perhaps arise from an old-fashioned but not entirely played-out attitude of disdain for the place to be given, within the hierarchy of knowledge, to the study of human relations and human behaviour. An over-narrow view of the film-medium itself may also at times colour our outlook on its applications to science. The camera has, of course, special qualities for the observation of time and of mechanical movement, and the roles it can fulfil in the 'exact' sciences are obvious. But its usefulness does not end there.

The camera as an instrument of research in the social sciences has so far been little developed. Even for investigating manipulative processes, of such demonstrable value to the study of workshop skills and of industrial conditions generally, its use still remains the exception rather than the rule. For more subtle and less tractable problems of human behaviour, its use has been even less explored. Two recent examples of the use of the camera in psychological inquiry—of maternal separation and of the reactions of children to the cinema—illustrate well some of the possibilities. A rather similar, though brief, use of the motion-picture camera occurred in "Children Learning by Experience", itself a remarkable 'anthology' of children's behaviour as an aid in the training of teachers. Less normal phenomena form the subject of a pioneer Canadian series of filmed case-histories for the use of psychopathologists. Here the camera records permanently, unobtrusively and 'objectively'. To take another branch of the social sciences, no subject offers perhaps so wide a scope for the film record as does anthropology. Among many instances, Dr. Mountford's "Tjurunga" and his other films of the Australian stone-age men reflect the interest, not only scientific but also sometimes æsthetic, of such visual reports. Indeed, the trained cinematographer might well be considered an indispensable member of all field-teams engaged in anthropological or ethnological studies.

The dramatic qualities of the film medium are also available to the social scientist for explaining his purposes and methods to the general public. The cinema can illumine, too, the social relations of science; and this is perhaps one of the most important of its functions. There is need for films which will explain to the man in the street what science is, how scientists think and work, and the limits and freedoms affecting their activities. To this task the cinema as an art can bring special qualities of imagination and human warmth.

RESEARCH COUNCIL OF ALBERTA

REPORT FOR 1953

THE thirty-fourth annual report of the Research Council of Alberta, to which are appended lists of committees, staff and publications, covers the calendar year 1953* and emphasizes a shift in emphasis in coal research towards the exploration of the chemical potentialities of coal. Besides this a palæobotanical study was made of the flora and biological origin of Alberta coal measures, as well as investigations into the chemical and colloidal structure of coals. The vertical electric tube furnace for the determination of volatile matter in coal, built in 1929, was redesigned and a 14-in. rotating, self-clearing grate and ancillary control and recording equipment, installed in 1952, was used to complete an evaluation of the combustion characteristics of typical Alberta coals; a study of water retention by coal was also completed. Investigation of the trace metals in oil-sands oil and other Alberta oils suggests that occurrence of vanadium and nickel may serve as a precise correlative for crude oils and that cretaceous oils in general have a common origin. Attention is being directed to the origin of the trace-metal carriers, the porphyrins, and studies are proceeding on the properties of the heavy oils of Alberta and the viscosity of dispersions of wet oil containing mineral matter. The survey of the quality of Alberta gasoline continued, further tests were made on the storage of aviation gasoline, and work also continued on the partial oxidation of butane, in which a new reaction system was designed and built, and on the production of carbon black in a tubular furnace.

Field work by the Geological Section included detailed studies of selected areas for uranium in north-eastern Alberta, along the north shore of Lake Athabasca, and in the north-central portion of the Pre-Cambrian outcrop area in Alberta and especially north of Fidler Point and Leggo Lake, as well as a Pleistocene study in east-central Alberta. A fundamental mineralogical investigation of montmorillonite, the chief constituent of bentonite, in which forty samples of montmorillonite were subjected to X-ray and differential thermal analysis, indicates that every montmorillonite is a complex and intimate mixture. Further work under the Highway Research Project indicates that the dispersing and other properties of lignosol are important factors, as well as the viscosity effects, in preventing the migration of soil moisture to the frost line, and that sodium hexametaphosphate is equally effective in preventing frost action. Soil surveys were concentrated largely in the Peace River area, and a reconnaissance survey of the Grande Prairie sheet completed the field work on some 750,000 acres. Irrigation research was commenced on the solonetzic soils of the projected Red Deer irrigation area to determine the response to irrigation of various methods of treatment.

In the Industrial Projects Section research and testing for industry are of increasing importance. The ten-year biological cycle now appears to have reached the collapse predicted, and various publications on these extensive investigations are now being prepared. Two other investigations in animal science related to the effect of 'management factors' on the

* Thirty-fourth Annual Report of the Research Council of Alberta, 1953. Pp. 41. (Edmonton: Queen's Printer, 1954.)

percentage hatch of turkey eggs and to the nutritive value of varying types of grass silage. A committee was appointed to study the fluoridization of municipal water-supplies. Routine measurements of solar ultra-violet radiation continued.

FREE NERVE ENDINGS AS TRANSDUCERS OF THERMAL STIMULI

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RECENT evidence suggests that the encapsulated nerve endings postulated by von Frey to subserve specifically the sensations of warmth and cold (Ruffini corpuscles and Krause end bulbs, respectively) are not related to thermal sensibility, for, among other things, thermal sensations are as easily evoked from regions devoid of them as from regions where such encapsulated endings occur[1–3]. Moreover, it has now been shown[4] that thermal sensations can be aroused from the cornea, a tissue devoid of blood vessels and innervated solely by nerves the terminals of which are unencapsulated (free). In normal hairy skin, which is not being subjected to deformation, there is evidence which suggests that free nerve endings do not give rise to propagated action potentials under isothermal conditions; they only discharge when thermal gradients occur in the skin in which they lie[5]. In support of this, Hodgkin and Katz[6] have shown that under isothermal conditions the resting potential of the giant squid axon is practically constant (the mean value being 47 mV.) between −1° C. and 20° C. It is also known[7,8] that a burst of propagated action potentials is evoked when a nerve trunk is heated or cooled relative to an adjacent region.

The mechanism by which a free nerve ending gives rise to a propagated disturbance when conditions are not isothermal has been compared[5] to the principle upon which a thermopile type of bolometer gives rise to an electromotive force. This analogy, though useful, must eventually be capable of expression in terms of the ionic hypothesis if the mechanism postulated is to be validated. What follows is an attempt to explain the discharge of propagated disturbances by free nerve endings under non-isothermal conditions.

A difference in temperature between the two junctions in a metallic thermocouple gives rise to a thermo-electric potential. This has two components: (1) due to the difference in potentials at the two metal–metal interfaces (Peltier e.m.f.), and (2) due to the difference in potentials in the two homogeneous metal conductors due to the temperature gradient (Thomson e.m.f.). Depending upon the metals used, the Peltier e.m.f. is ten to a hundred times greater in magnitude than the Thomson e.m.f. The free nerve terminals are less than 1 micron in diameter. Since the light microscope cannot resolve boundaries in objects so small, it is not known whether an axoplasmic filament is in fact a homogeneous medium in equilibrium with the extracellular fluid or whether it is a miniature of the axon with two interfaces, for example, extracellular fluid/membrane/axoplasm[9]. It is likely that the effects which are postulated below will occur in either case, but for the sake of brevity it is assumed that the nerve terminal can be regarded as a medium in which ions are adsorbed in equilibrium with extracellular fluid containing free ions. A phase boundary potential will exist at the interface, and if a portion of the interface is heated or cooled with reference to another portion, a potential difference consisting of the following components will be set up in the system:

(1) The difference in the interface potentials at the two temperatures. This is analogous to the Peltier e.m.f.

(2) The thermal diffusion potentials in the extracellular fluid and in the nerve terminal due to the temperature gradient. This is analogous to the Thomson e.m.f.

The effect of the thermal diffusion potential in the extracellular fluid can be estimated approximately, since the initial thermal diffusion potential in solution before the Soret equilibrium is established is given by:

$$-\sum_i \frac{t_i Q^*_i}{z_i F T},$$

where t_i, z_i and Q^*_i are the transference number, valency and heat of transfer respectively of the ith ion and the summation is taken over all ions in the solution[10]. For extracellular fluid in the giant squid axon this potential may be calculated (on the assumption that all ionic heats of transfer are equal to 1 kilocal./mol.) to be about 40 microvolts per degree. This e.m.f. would not be enough to cause the discharge of a giant squid axon. It is known that the capacity of a nerve membrane[11] is of the order of 1 microfarad. cm.$^{-2}$. A change of potential of 1 mV. across such a capacity requires a charge transfer of 10^{-9} coulomb cm.$^{-2}$, or approximately 10^{-14} gm. equivalents cm.$^{-2}$ of a univalent ion. This is a small fraction of the amount of any diffusible ion transferred per second across the membrane (10^{-10} to 10^{-12} gm. equivalents cm.$^{-2}$, ref. 12). Clearly a local potential change of a magnitude greater than a thermal diffusion potential in a homogeneous phase would be produced across the membrane if the diffusion-rate of any one ion was affected, even to a relatively small degree, by a change in temperature. In this connexion, it is of great interest to note that Hodgkin and Keynes have recently observed that the activity of the 'sodium pump' in extruding sodium ions from the surface of the membrane of the giant squid axon has a high temperature coefficient[13]. It is therefore not unreasonable to assume that for a free nerve terminal in contact with extracellular fluid, the major contribution to the thermal e.m.f. would also arise at the interface between the phases. In this case there would be an exact analogy with a metallic thermocouple, the electrons of the latter being replaced by ions common to both phases. The existence of such a thermopotential would provide a stimulus to nerve terminals identical with that provided by the passage of a d.c. current across the nerve[14]. The sign of the potential will depend upon whether the tip of the fibre is heated or cooled with respect to the parent axon. The local ionic currents will change in direction accordingly; however, in either event, the nerve may discharge, being 'triggered' either at the tip of the fibre or near the stem axon. There is no need, therefore, to postulate different mechanisms to account for the response of free nerve endings to 'warm' and 'cold' stimuli. The

spontaneous activity of end-organs in the ampullæ of Lorenzini[15] and the spontaneous activity of thermal receptors in the tongue of the cat[16] are explicable on the basis of non-isothermal conditions across the nerve terminals involved.

An attempt to measure this effect was made by Bernhard and Granit[7]. They neglected, however, to ensure that both their test electrodes were at the same temperature. Hence, the measured potentials included the variation in potential of the electrode system with temperature. This phenomenon is well known[17–19]. Experiments have shown that the temperature coefficient of the e.m.f. of the cell,

$$\begin{matrix} \text{Ag—AgCl} \mid 0{\cdot}9\%\ \text{NaCl} \mid \text{Ag—AgCl}, \\ T \qquad\qquad T + \Delta T \end{matrix}$$

is 400 microvolts per degree (heated electrode positive), which is comparable with the value obtained by Bernhard and Granit in their system, which included a nerve fibre.

Any experiment to detect thermo-electric potentials in nerve must be so arranged as to exclude this electrode effect by keeping the electrodes at the same temperature. In any such experiment it is impossible to avoid thermal diffusion potentials in the salt bridges or other devices used, but these effects are certainly much smaller than potential changes at the electrodes if they are not kept at the same temperature. [Aug. 14.

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BIOLOGICAL ROLE OF DEOXYRIBONUCLEIC ACID

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ACCORDING to the most widely accepted theory, deoxyribonucleic acid or deoxyribonucleic acid-protein is the primary genetic material and functions by acting as a template. Another theory has been proposed which postulates that ribonucleic acid-protein is the primary genetic material, specificity at each genetic locus being determined by different types or proportions of ribonucleotides and polyribonucleotides released by the ribonucleic acid-protein at that locus, alleles representing conditions at a locus that result in different rates of release of nucleotides[1]. The former hypothesis requires among other things that deoxyribonucleic acid be continually present in the nucleus and chromosomes. Some previous observations[2,3], together with results that will be briefly presented here, indicate that it is absent from the pronuclei of some echinoderm eggs. If these observations are correct, they would invalidate the deoxyribonucleic acid–template theory, but would offer no cause for embarrassment of the hypothesis that ribonucleoproteins are primary genetic materials.

The pronuclei of the eggs of *Asterias forbesii* and *Arbacia punctulata* have been shown to give a Feulgen-negative reaction which could not be attributed to dispersion of the deoxyribonucleic acid in an unusually large nuclear volume[2,3]. In a suspension of mature *Arbacia* eggs it was possible to account for the deoxyribonucleic acid found by isotope dilution analysis with ^{14}C-thymine as being contained in contaminating somatic cells[2], the polar bodies, and the egg cytoplasm. A similar but more precise analysis has been carried out on a preparation of mature eggs of the sea urchin *Tripneustes ventricosus*.

The specific activity of the thymine added was 4,020 counts per minute per microgram and of that recovered 1,389, with maximum deviations of 1·16 per cent and 1·57 per cent respectively for triplicate aliquots assayed. Agreement of the absorption spectrum of the recovered thymine with that of pure thymine was better than 1 per cent. The amount of thymine found in the preparation, which contained $1{\cdot}435 \pm 0{\cdot}50 \times 10^8$ eggs, was 68·18 μgm. The proportion of contaminating somatic nuclei to eggs in the preparation was $0{\cdot}512 \pm 0{\cdot}016$. Analyses on sperm of the same species gave the amount of thymine per sperm as $12{\cdot}14 \pm 0{\cdot}15 \times 10^{-8}$ μgm. Making the assumption, which appears to be justified by various reports in the literature, that each somatic nucleus contained twice the amount of deoxyribonucleic acid found in the sperm, the amount of thymine which could be assigned to the contaminating somatic nuclei was 17·85 μgm. The remainder was equivalent to $35{\cdot}07 \times 10^{-8}$ μgm. of thymine attributable to each egg and its polar bodies. This quantity was 2·89 times the amount of thymine per sperm, or almost exactly the amount expected in the polar bodies alone if each contained the haploid quantity of deoxyribonucleic acid. Alternative assignment of the thymine equally to all members of the meiotic tetrad resulted in each having only 70 per cent of the amount found in sperm. The 30 per cent deficiency is 32 times the standard error of the determinations and therefore quite unlikely to occur by chance. Such equal distribution was not justified by the cytological observations, which showed that the polar body nuclei were Feulgen-positive, whereas the egg pronucleus was Feulgen-negative. Thus within the limits of error of the determinations, there appeared to be no deoxyribonucleic acid-thymine and hence no deoxyribonucleic acid in the eggs themselves. The possibility that the deoxyribonucleic acid of sperm and of immature oocytes would contain thymine, while that of a hypothetical deoxyribonucleic acid in the mature egg would not, was rejected as highly improbable.

Mature eggs of *Arbacia* were centrifuged at 78,000 *g* for 30 min. and then treated by the Feulgen procedure after fixation. No aggregates of Feulgen-positive material could be found in the nuclei of these eggs as had been reported by Brachet for eggs in the germinal vesicle stage[4]. By direct analysis of

isolated nuclei of *Asterias* eggs in the germinal vesicle stage, the deoxyribonucleic acid content per nucleus was found to be 6·2 times that of sperm of the same species. In the three species investigated, both staining procedures and chemical analysis revealed an abundance of deoxyribonucleic acid in the nuclei of young oocytes, although no clear evidence could be found for its presence in the pronuclei of the mature eggs of the same species.

Since these eggs can be induced to develop parthenogenetically, absence of deoxyribonucleic acid from their nuclei would argue against the theory that this acid is the primary genic material in the sense that it is the initiator of gene reactions. However, a regulatory role for deoxyribonucleic acid would not be so excluded. In the hypothesis mentioned previously, it was proposed that deoxyribonucleic acid had such a function. Structural similarity between ribonucleic and deoxyribonucleic acid is suggested by the observations that deoxyribonuclease (or depolymerized deoxyribonucleic acid) will reduce the rate of removal of ribonucleic acid nucleotides from nuclei by ribonuclease[5], and that after removal of its purines, deoxyribonucleic acid is digested by ribonuclease[6]. With sufficient structural homology in the two types of nucleic acids, competition between them in cellular reactions may be assumed to be probable, as is indeed suggested by the first of the observations mentioned above. Furthermore, since the rate of turnover of ribonucleic acid *in vivo* is known to be rapid, whereas that of deoxyribonucleic acid is very slow, it follows that where such competition exists, the latter will act as an inhibitor of the former. The hypothesis may be generalized to include similar inhibitory action of deoxyribonucleic acid derivatives toward analogous ribose compounds. Support for this generalization may be found in Carter's finding of inhibition of mitochondrial oxygen consumption by deoxyriboside-5′-phosphate, which is overcome by adenine ribose phosphate[7].

The hypothesis will satisfactorily account for a variety of biological observations, involving nucleic acids such as the *Ds—Ac* modifiers of *Zea*[8], maternal influence in inheritance in mammals and somatic influence on pollen in plants[9,10], the behaviour of bacterial transforming substances[11,12], and of provirus[13]. Its usefulness becomes especially apparent in providing an interpretation of turnover studies on bacteriophage[14] and behaviour of interspecific hybrids in the genus *Rana*[15], for which no adequate explanation has been found in terms of other current theories. In the case of bacteriophage, it has been shown that synthesis of new deoxyribonucleic acid after infection occurs in excess of and in advance of the need for actual incorporation into the new phage particles[14]. The deoxyribonucleic acid synthesized before any new phage particles are formed is approximately equal to the amount originally present in the bacterium—that is, in terms of the present theory, an amount which is sufficient for the antagonism of the genic apparatus of the bacterium. As described by Brachet, the hybrid *Rana* embryos ordinarily cease to develop at the end of the blastula stage, at which time the amount of nuclear deoxyribonucleic acid they contain is markedly diminished, ribonucleic acid turnover is enhanced, while oxidations are diminished as compared with the normal. Since transplantation of the blastopore lip to a normal embryo will permit continued growth and development, diffusible substances seem to be involved[15]. In terms of the present hypothesis, the following interpretation of the observations is possible. The deficiency in deoxyribonucleic acid suggests the release of unusual amounts of its derivatives to the cytoplasm, with the result that oxidations will be reduced by blocking of the ribonucleotides involved, and since a good portion of the deoxyribonucleotide has been removed, the nuclear ribonucleic acid which is normally more reactive than that of the cytoplasm will be capable of more rapid turnover than normal. Growth after transplantation becomes possible by diffusion into the transplant of ribose compounds of the host, or by removal of excess deoxyribose compounds of the transplant into the host.

A full account of the experimental details and of the hypothesis will be presented elsewhere. This investigation was supported by a grant from the Division of Biology and Medicine of the United States Atomic Energy Commission. [June 27.

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DIFFERENTIATION OF GROWING AND NON-GROWING BACTERIA BY A STAINING TECHNIQUE

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IT has been known for some years that growing bacteria are more strongly basophilic than non-growing bacteria. In *E. coli* this difference has been attributed to the presence of unbound ribonucleic acid in growing bacteria[1]. That ribonucleic acid is responsible in all bacterial species is improbable in view of the presence in some of inorganic polyphosphates[2] the abundance of which appears to vary like ribonucleic acid with the physiological condition of the bacterium. In order to supplement other evidence for the presence of unbound ribonucleic acid and to seek a convenient microscopic means of assessing the abundance of this constituent in *E. coli* (*N.C.T.C.* No. 1100) the affinity of this bacterium for the weakly basic dye toluidine blue was investigated.

It became evident that, by an initial acid extraction of the bacteria and by the application of the dye at a *p*H which would reduce interference from protein to a minimum, a staining technique, applicable to all the bacteria tested (including Gram-positive bacteria), could be obtained by which growing cells alone showed marked basophilia.

A quantitative assessment of the basophilia of growing bacteria, taken from an aerated casein/casein/

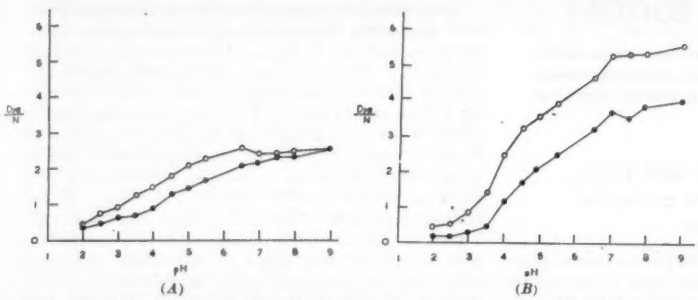

Fig. 1, *A*. Absorption of toluidine blue by non-growing and growing *E. coli* bacteria; *B*. Absorption of toluidine blue by acid-extracted non-growing and growing *E. coli* bacteria. —●—●—, non-growing bacteria; —○—○—, growing bacteria. The basophilia is expressed as weight of dye absorbed/weight of bacterial nitrogen

yeast[3] culture during the period of maximum growth and division-rates, and non-growing but viable bacteria, taken from the culture when growth had ceased, was obtained by suspending the washed bacteria in 0·2 per cent toluidine blue solution in 0·05 *M* buffer and extracting the dye absorbed with normal hydrochloric acid.

The influence of an acid extraction on the basophilia of growing and non-growing bacteria and the influence of *p*H can be seen in Figs. 1 *A* and *B*. The contrast between growing and non-growing bacteria is optimal in acid-extracted bacteria at *p*H 3·5; the quantitative difference in dye absorption is optimal above *p*H 4·0. For the purpose of microscopical observation, however, the staining of rapidly growing cells is sufficiently intense at *p*H 3·5 for advantage to be taken of the optimal contrast afforded by this *p*H.

At *p*H 3·5 untreated growing bacteria appear to absorb approximately 80 per cent more dye than untreated non-growing bacteria; acid-extracted growing bacteria appear to absorb approximately 200 per cent more dye than acid-extracted non-growing bacteria. Under the conditions of determination, however, part of the dye measured as absorbed by the bacteria is derived from dye passively contained in the bacteria and dye present in solution retained with the bacteria after centrifugation. This accounts for the fact that the assessment of basophilia by microscopic observation of stained bacteria suggests a far greater contrast between acid-extracted growing and non-growing bacteria than expected from the measurements made. Fig. 2 shows an artificial mixture of acid-extracted growing and non-growing *E. coli* bacteria stained with toluidine blue in the manner described below. The very weakly basophilic non-growing cells have absorbed sufficient dye to make them just visible.

In order to render weakly basophilic bacteria more visible and to facilitate the distinction between growing and non-growing bacteria, the staining procedure finally adopted and described below includes the use of eosin as a counter stain.

The culture was treated immediately upon reaping with sufficient concentrated hydrochloric acid to give a concentration of 0·33 *N* hydrochloric acid. The bacteria were centrifuged down, washed once in 0·33 *N* hydrochloric acid, then taken up into a little water and treated gradually with '*IR* 400' (OH) resin until the *p*H was 3·5–6·0. A loopful, applied to a slide, was air-dried and heat-fixed. The preparation was stained at 45° C. for at least 10 min. in 0·5 per cent toluidine blue made up in 0·05 *M* formate buffer at *p*H 3·5, washed for 0·5 min. with distilled water, blotted and dried. It was then stained for 30–60 min. in 0·05 *N* acetic acid saturated at room temperature with eosin (water-soluble, yellowish), washed briefly with tap water, blotted and dried. This staining procedure resulted in non-growing bacteria staining pink and growing bacteria blue-violet.

If, as is most likely, the high content of ribonucleic acid in growing Gram-negative bacteria is responsible, the intensity of the blue staining will depend upon the growth-rate after the first generation[4].

The potential use of the staining technique for assessing the viability of bacterial suspensions has been considered. For the assessment of the viability of a suspension of bacteria derived from a fully-grown culture, two methods have been entertained.

One method involves the counting of pink-staining bacteria before and after incubation of the bacteria in a medium that supports very rapid growth and for a period that allows the viable bacteria present to attain a high rate of growth and change their staining reaction. This method requires the counting of pink-staining bacteria by a ratio count to inert particles of known concentration.

Another method requires some knowledge of the behaviour of the bacteria. If the stationary phase of the bacterium when incubated in fresh medium is known, a direct assessment of the degree of viability can be obtained from a ratio count of pink-staining and blue-violet-staining bacteria after incubation for the duration of this phase.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication. [Aug. 27.

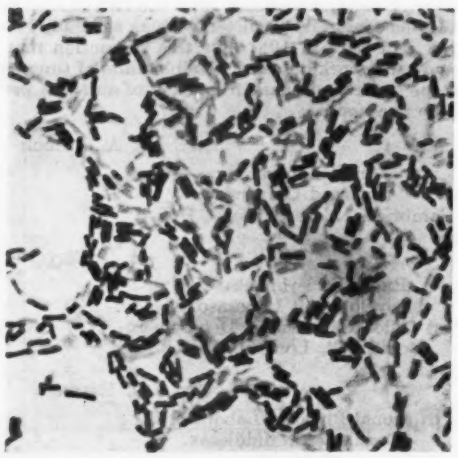

Fig. 2. An artificial mixture of acid-extracted growing and non-growing *E. coli* bacteria treated with toluidine blue at *p*H 3·5

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

World-wide Frequency and Time Comparisons by Means of Radio Transmissions

For many years standards of frequency have been made available to users over a wide area by means of radio transmissions, the carrier waves of which are controlled by the standard; and the frequencies of 2·5, 5, 10, 15, 20 and 25 Mc./s. have been allocated to this purpose by international agreement. Frequency standards can now be maintained in operation with a stability of a few parts in 10^9 per month, and they can be intercompared in the laboratory with a precision of $\pm$ 1 part in 10^{10}. There is, however, a loss of accuracy due to transmission, and although it has been found that $\pm$ 1 part in 10^8 can be achieved under suitable conditions, the accuracy in general is limited to about $\pm$ 2 parts in 10^7 because progressive movements of the ionospheric layers at which the waves are reflected cause a steadily increasing or decreasing path-length and a consequent Doppler-effect frequency change. In view of this limitation, an experimental transmission on 60 kc./s. was included in the United Kingdom service when this was resumed in 1950, with the call sign *MSF*. The ionospheric layer at which such low-frequency waves are reflected is known to be comparatively stable, and the ground-wave of the transmission, which is, of course, not affected by changes in the ionosphere, is received over a useful area. Results[1] obtained at the National Physical Laboratory show that this transmission can be used in the United Kingdom with an accuracy of $\pm$ 1 part in 10^9 in an observation time of a few minutes; and in spite of its low power of 10 kW., it has been received and measured at Harvard University with the same precision by a somewhat different technique in a time of about 10 min. Higher accuracies of comparison can be obtained by averaging the observations over longer periods.

The *MSF* transmissions are operated from the Post Office Radio Station at Rugby, where the powerful 16 kc./s. transmitter *GBR* is also located. The carrier wave of this transmitter is now controlled by the standard used for the *MSF* transmissions in order to facilitate measurements at great distances whenever *GBR* is in operation.

A typical photographic record taken at Harvard and including the results obtained with both the 60 kc./s. and the 16 kc./s. transmissions is reproduced as Fig. 1. The edge of a dark band represents the arrival time of a particular phase of the carrier wave on a time-scale derived from the local standard; and when it forms a horizontal line the frequency of the received signal is in exact agreement with that of the local standard, or is in simple relationship with it, such as 16/100 and 60/100 in this case. The slope corresponding to a deviation from the local value of 1 part in 10^9 has been indicated in the diagram. The smoothness of the edges of the trace demonstrates that the propagation path is relatively free from short-period fluctuations, but the changes in slope are due to gradual changes in the height of the reflecting layer. Closer checking by independent means of the frequency of the local standard will enable the frequency changes associated with the diurnal movements of the layer to be accurately measured and compensated in the frequency comparisons.

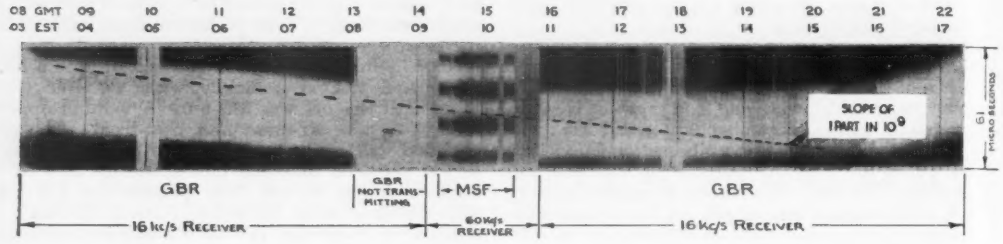
08 GMT 09 10 11 12 13 14 15 16 17 18 19 20 21 22
03 EST 04 05 06 07 08 09 10 11 12 13 14 15 16 17
SLOPE OF 1 PART IN 10⁹
61 MICRO SECONDS
GBR
GBR NOT TRANSMITTING
MSF
GBR
16 kc/s RECEIVER
60 kc/s RECEIVER
16 kc/s RECEIVER

Fig. 1

These results, which will be reported more fully elsewhere, are clearly of significance in problems of frequency control, international frequency and time standardization, and navigational aids based on phase comparison; and the possibility of securing comparisons of frequency and therefore of time-interval to a precision of $\pm$ 1 part in 10^9 on a world-wide basis is probably also of interest in a much wider field. Measurements to this accuracy must at first be on a comparative basis, since the unit of astronomical time cannot be predicted with an accuracy greater than $\pm$ 1 part in 10^8; but this restriction may be removed if work on other possible units of time based on the natural resonant frequency of an atom proves to be successful.

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Preparation of Aluminium of Extreme Purity by the 'Zone Fusion' Process

THE special properties of aluminium refined by double electrolysis and of conventional purity 99·99–99·998 per cent are well known. We have considered the application to this material of the 'zone fusion' process, which permits the production of germanium of extreme purity[1]. In our experiments we have employed a bar of such refined aluminium about 40 cm. long and 4 cm.² in cross-section. This bar was placed in a boat of pure alumina and a length of 6–8 cm. raised to the melting point in a high-frequency furnace, the zone of fusion being traversed through the furnace at the rate of 5 mm. an hour.

In our first experiments notable purification of the 99·998 per cent metal after three such treatments was obtained[2]. After cold work, such material recrystallizes in large grains at a temperature of − 20° C.

After nine such fusion processes, the analyses being carried out with the aid of radioactive elements[3], we are led to believe that the conventional purity clearly exceeds 99·999 and is probably very near 99·9995.

By the classical strain-anneal technique we have prepared this aluminium in the form of single crystals. For this the ingot was rolled at a temperature near that of liquid nitrogen, since this metal recrystallizes at − 50° C., after which it was subjected to the usual treatment.

Measurement of the resistivities in liquid hydrogen and liquid helium[4] shows very considerable differences as compared with the refined aluminium of 99·99 and 99·998 per cent.

Fig. 1 shows the very important differences in the ratio $R_0/R_{20\cdot4\,K.}$ (the ratio of the resistivity at ordinary temperatures to that at the low temperature) for aluminium purified by three treatments (curve 3) and nine zone fusions (curve 4).

It was important to know what proportion of the metal had been purified after nine treatments; that is, what length of the bar consisted of metal of the highest purity. In Fig. 2 we have plotted the distances from the head of the bar as abscissæ and the ratio $R_0/R_{20\cdot4°K.}$ as ordinates. This shows that the first 30 cm. of the bar, of total length 45 cm., consist of this highly purified material.

Such experiments demonstrate the interest which this method has for ordinary metals. The extreme degree of purity leads to new properties in many different fields, among which we are at present studying, in the laboratory at Vitry, problems of recrystallization, polygonization[5], electrical conductivity, corrosion and grain boundary fusion[3–6].

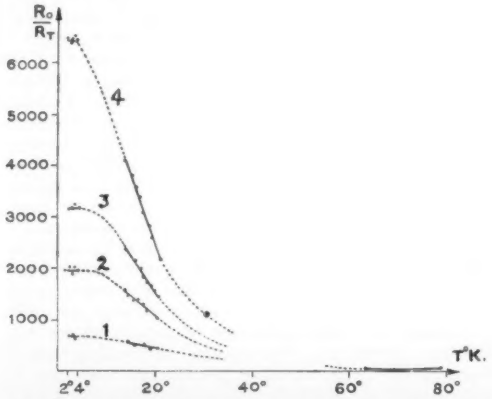

Fig. 1. Changes in the ratio R_0/R_T for different specimens. (1) 99·99 per cent aluminium; (2) 99·998 per cent aluminium; (3), as (2), after three treatments; (4), as (2), after nine treatments

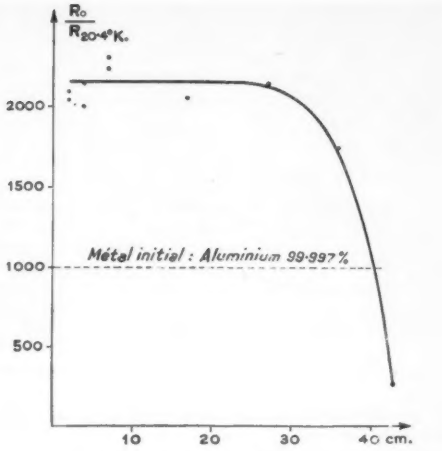

Fig. 2. Purification of 99·997 per cent aluminium after nine treatments. Note that the first 30 cm. of the bar consists of highly purified metal

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Photoelastic Effects in Microscopic Fibres

THE application of fairly high pressures to fibre specimens on the microscope has been found to produce types of photoelastic stress patterns in cotton and nylon fibres. The method, which is modified from the original technique devised by Boddy[1] and that due to Merton[2], consists in applying a load to a lever system which exerts pressure on the condenser. The front lens of this is replaced with a sapphire sphere $\frac{1}{16}$ in. or $\frac{1}{8}$ in. in diameter. This operates through the cover slip on the specimen. Thus light rays can be focused through the sphere and through the material while pressure is applied or released, and the behaviour of the fibres watched throughout the process.

The interferometric slides and cover-slip of semi-metallized glass due to Merton give rise to optical path differences by reflexion, and the stress fringes in the materials may be observed without using polarizers.

Fig. 1 shows them in a cotton fibre after the pressure has been removed, and it is interesting to note that they remain in this material for some considerable time. A similar fringe system can be produced in a

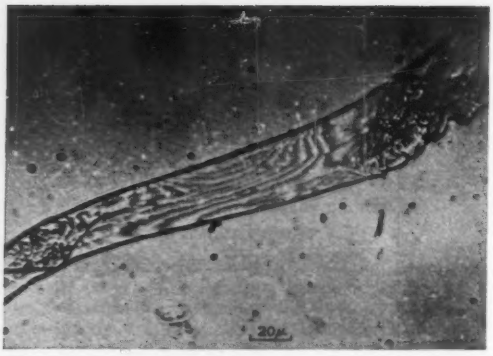

Fig. 1. Cotton fibre showing stress fringes after applying pressure

nylon fibre, where they also remain after releasing the pressure.

With collagen fibres the stress fringes also occur, but are rapidly released with the release of pressure. With cotton, two pressure impacts at different places will produce two series of fringes which may interfere like two sets of ripples on a pool.

The impact of pressure if applied suddenly results in waves of fringes which, particularly with collagen, appear to travel along the fibre axis some considerable distance before being damped.

Further work on the elastic properties of such fibres is in progress and will be reported elsewhere.

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A New Approach to the Study of Electric Fields produced by Growing Roots

The electric fields primarily developed across the walls of plant cells give rise to an integrated field associated with a growing plant organ. Information from the literature with regard to such electric fields associated with plant organs is contradictory and has led to conflicting theories; and the conflict in experimental evidence has never been satisfactorily resolved. An investigation of the literature seems to us to show that artefacts developed at points where measuring probes make contact with the plant would, in most cases, swamp the normal field which it is desired to investigate.

We have made an essentially new approach by studying the currents which are generated by a plant organ in a weakly conducting medium. Potential differences are measured between points in the medium near the plant without disturbing its normal growth in any way. If these measurements are made in a suitable pattern, information about current density and direction, and the electric power developed by the plant, can be obtained. Consistent results have been obtained with bean and onion roots grown in water. As a first step in the investigation of the electrical processes associated with an organ as a whole, the changes have been observed in the pattern of electric potentials in the water which occur when growth is rapid and when it is inhibited.

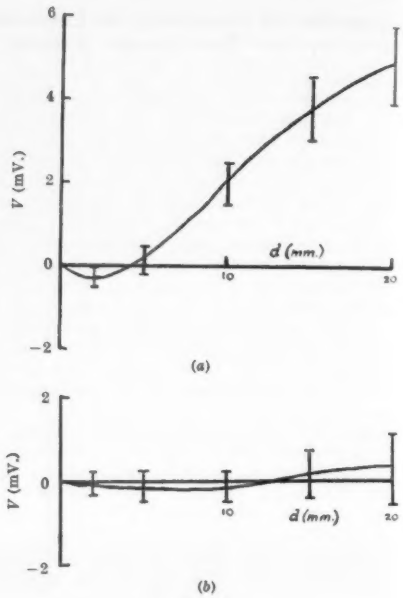

Fig. 1

Fig. 1(*a*) shows the pattern observed with bean roots growing rapidly and uniformly in aerated water at 25° C. V is the potential relative to that of the root-tip of points close to the root in the external medium (0·0001 N potassium chloride solution) and this is plotted against the distance d from the tip. The growth-rate is about 0·8 mm. per hour.

Fig. 1(*b*) shows the corresponding pattern produced when growth is inhibited. Inhibition has been produced by methods as different as the addition of indole acetic acid to the water in which the root was growing, and raising the temperature of the root. In the case of the addition of indole acetic acid, the effect was reversible, and when growth was resumed the electrical pattern returned to that associated with normal growth.

Figs. 1(*a*) and 1(*b*) show averages in experiments each of which comprised about twenty-five plants, the vertical lines through the points giving the 95 per cent confidence limits.

The electrical pattern is seldom static and shows small slow variations with time even when all environmental factors known to affect the electric field are controlled. In conditions other than that of straight rapid growth, the potential pattern may differ considerably from that discussed. In some conditions the root is observed to produce persistent and relatively rapid oscillations in its electrical pattern. These oscillations are often practically sinusoidal, with periods ranging from 4 to 15 min. or more. The more rapid oscillations are more common.

Observation of these rapid changes of electrical pattern has been made possible by the development in this laboratory of an automatic apparatus which records at frequent intervals the electric potential differences between a number of points adjacent to the root grown in water. The oscillations can be induced by experimental treatment, such as by introducing an obstacle which impedes elongation of the root, or by inducing bending by wounding. They also appear spontaneously, accompanying variations

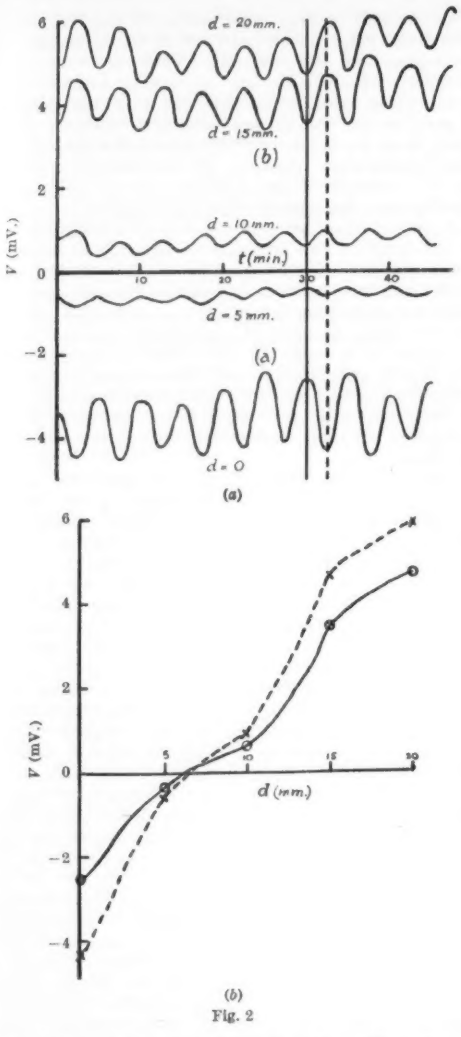

Fig. 2

in growth such as spontaneous bending. They do not occur when the root grows rapidly and evenly.

Fig. 2(*a*) shows a graph of potential against time in a typical case where electrical oscillation accompanied bending. Each trace shows the potential V relative to a distant point in the bath plotted against time t, for a point near the root at a distance d from the root-tip. The graph shows simultaneous potentials for several values of d. Note the phase differences at a and b. Fig. 2(*b*) shows the corresponding graph of potential plotted against distance from the root-tip. Two traces are shown giving potentials at times corresponding to a crest and a trough of the oscillatory potential. Where the two traces cross, the phase changes by π.

These investigations, which are part of a general study of patterns of morphogenesis, are being continued and will be described in more detail elsewhere.

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5-Hydroxytryptamine : its Occurrence in Cowhage

The trichomes from the pods of *Mucuna pruriens* DC., which constitute cowhage, have long been known to cause intense itching, and some pain, when applied to the human skin. Broadbent[1] concluded, from pharmacological and histological studies, that the itching was not a mechanical effect of the trichomes but was due to the presence of a histamine-liberating substance.

In seeking to identify the active principles, we have examined a crude extract of cowhage prepared by Dr. P. Hey. 5-Hydroxytryptamine was found to be present. The concentration of the substance in the trichomes, as determined by pharmacological assay, was of the order of 0·015 per cent.

Though 5-hydroxytryptamine has been found in certain mammalian tissues and serums[2], in the gastro-intestinal and splenic extracts of fish and ascidians[3], in toad venom[4], in the salivary glands of octopods[5], and in wasp venom[6], we believe this to be the first record of its occurrence in a plant.

Armstrong *et al.*[7] have shown 5-hydroxytryptamine to be more effective than histamine as a cutaneous pain-producer in man. It is thus probable that 5-hydroxytryptamine is a factor in the causation of pain following the application of cowhage to the skin. We cannot yet say, however, whether it is the principle responsible for the sensation of itching. Further work is in progress.

An active extract of cowhage was prepared by moistening with alcohol, extracting with cold water and evaporating the aqueous extracts to dryness below 35° ; 100 gm. of the crude drug gave 10 gm. of extract. This material elicited the same type of response from guinea pig ileum and rat uterus as did 5-hydroxytryptamine (acid oxalate), and was not antagonized by atropine (5 ng./ml.) or mepyramine (50 ng./ml.)[8]. Under the same conditions the responses to acetylcholine and histamine were almost completely abolished. Lysergic acid diethylamide, at a concentration[8] of 0·1 μgm./ml., reduced the ileum responses to equi-effective doses of the crude extract and of 5-hydroxytryptamine to the same extent.

Fractionation of the original crude extract was controlled by pharmacological assay of the fractions on the guinea pig ileum. By re-extraction of the crude material with limited amounts of water, followed by chromatography of the soluble material on a powdered cellulose column using *n*-butanol/acetic acid/water (100 : 10 : 30), a fraction with 125 times the activity of the original was obtained. When this fraction was subjected to ascending chromatography on Whatman No. 1 paper, using *n*-butanol/acetic acid (10 : 1) saturated with water, 85 per cent of the total activity was concentrated in a zone corresponding to a substance with $R_F = 0{\cdot}42$, which is the value shown by 5-hydroxytryptamine in the same system. Material eluted from this zone was also identical with 5-hydroxytryptamine in its reactions with ammoniacal silver nitrate, with diazotized sulphanilic acid, with Ehrlich's reagent, and with Jepson and Stevens's ninhydrin/acetic acid reagent[9], which last is specific for a very narrow range of tryptamine derivatives. Aqueous solutions of the most active fractions had the following light absorption : $\lambda_{min.} = 247$ mμ, $\lambda_{max.} = 273$ mμ, $\lambda_{inf.} = 300$ mμ. Hamlin and Fischer[10] give the absorption of 5-hydroxytryptamine at *p*H 5·4 as $\lambda_{min.} = 250$ mμ, $\lambda_{max.} = 275$ mμ, and $\lambda_{inf.} = 299$ mμ.

Further details of this work will be published elsewhere.

We thank Prof. B. Lythgoe and Prof. W. A. Bain for their advice and encouragement, and Mr. J. Harley-Mason for a sample of 5-hydroxytryptamine.

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Oct. 7.

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Perpendicular Orientations in Polyethylene

Perpendicular orientation (chain-molecules perpendicular to an axis of rotation) has been frequently reported in studies on polyethylene. I have shown[1] that very similar X-ray patterns can be given by two entirely different perpendicular structures: (i) where the *a*-axis is parallel to the fibre-axis and consequently *b* and *c* are perpendicular to it; (ii) where the *b*-axis is an axis of cylindrical symmetry, and the *b*-axes themselves are randomly arranged in planes perpendicular to the direction of draw, which itself is perpendicular to the X-ray beam.

The finer details of the X-ray patterns have now been examined more closely in order to establish the existence of (i) and (ii) from X-ray evidence alone. The samples were prepared in two different ways in an attempt to produce these structures: (*a*) fully drawn and relaxed at 110° C.; (*b*) crystallized during flow while cooling from the melt[1]. The randomization of the *b*-axes in planes perpendicular to the fibre-axis in structure (ii) causes a characteristic spreading of the 200 and 110 arcs[1], as shown in the first part of Table 1. This spread could always be observed in samples (*b*).

Table 1. Theoretical Position of Maxima of Some Reflexions in Structures (i) and (ii) and their Theoretical Spreads in Structure (ii).
The spread given is inherent in the structure and is not due to disorientation

Reflexion	Structure (i) Maxima	Structure (ii) Maxima	Structure (ii) Spread
110	33° from equator	34° from equator	Arc of 69° bisected by the equator
200	Meridian	Meridian	Along the whole ring
020	Equator	Equator	None
011	Equator	25–30° off meridian	The whole ring except for 44° on the meridian
201	38° off equator	Meridian	The whole ring
121	15° off equator	45–60° off equator	The whole ring except for 52° on the meridian

To obtain more conclusive X-ray evidence, reflexions other than *hk*0 were investigated, in particular, 011, 201 and 121. These are very weak, especially when drawn out in more or less extended arcs. Close comparison revealed that the patterns of samples (*a*) and (*b*) are different. Table 1 shows what is to be expected from structures (i) and (ii). The figures were obtained by the method given in ref. 1. Because of the difficulty of reproducing the photographs the effects will be described.

Reflexion 011. In samples (*a*), this reflexion was in the form of two arcs on the equator as expected from structure (i). In samples (*b*), only faint traces of the reflexion were visible on the equator, whereas there were pronounced maxima at about 25°–30° off the meridian. Caution was needed in the localization of the latter, because the 310 reflexion, corresponding to a nearly identical spacing, has maxima at a similar angle for both (i) and (ii). However, it was possible to establish that the maxima in samples (*b*) are composed of both reflexions, in agreement with structure (ii).

Reflexion 201. Here samples (*b*) gave the clearer answer, as the maxima were found to be on the meridian, as follows from (ii). With samples (*a*), the position of the maxima appeared to be at 38° from the equator, but the effect was not clear enough to be conclusive. To remove possible doubts, drawn samples were relaxed successively in small steps by exposing them to increasing temperatures from 94° to 108° C. It was found that the relaxation proceeded by a continuous tilting of the crystallites around their *b*-axes until the *c*-axes were perpendicular to the fibre direction. Also, the doubtful 201 reflexion followed the course required by this tilting until the last stage, where it merged with the 220 reflexion, its definition being further reduced by an increasing spread towards the meridian (arising from the geometry of the reciprocal lattice). These results leave no doubt about the fully relaxed samples having structure (i) as stated previously, also by other authors.

Reflexion 121. This reflexion gave the clearest evidence on the points in question. Samples (*a*) gave extended equatorial arcs consistent with structure (i) as the small split is not expected to be resolvable. With samples (*b*) the maxima were broad but clearly at about 45–60°, being connected across the equator, and having abrupt ends at about 30° off the meridian, in agreement with (ii).

These observations confirm that the samples prepared by relaxation and by crystallization under flow have basically different structures, although the principal features of their X-ray patterns are very similar.

According to private information from Holmes *et al.*, the commercial polyethylene samples used by them in their earlier work[2] have been re-examined. The positions of the relevant reflexions indicated that a few of their samples had structure (ii) and not (i) as previously published, and for the majority the X-ray evidence alone was not sufficient to distinguish between the two alternatives. In my opinion the existence of structure (ii) in commercial films is to be expected, as crystallization might occur during flow while the solidifying film is being wound up in the course of manufacture[2].

I wish to acknowledge the contribution of Dr. D. R. Holmes and Mr. R. P. Palmer, Imperial Chemical Industries, Ltd., Welwyn Garden City, whose

first observations on their commercial samples initiated the present work; further, I wish to thank Dr. A. F. Wells for his interest and help.

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A Simple Microtitration Method for the Determination of Calcium and Magnesium in the Hæmolymph of Insects

ACCORDING to several authors[1,2], the direct titration of calcium and magnesium with ethylenediamine tetraacetate has yielded very good results, especially in the determination of water hardness and in clinical investigations of blood plasma. Since other methods described for the determination of calcium and magnesium are rather laborious, and micro-scale determination is liable to large errors, we have tried the direct titration with ethylenediamine tetraacetate using the well-known Linderstrøm–Lang micro-titration technique. Determinations have been carried out on some species of Blattaria: *Periplaneta americana*, *Periplaneta australasiae* and *Blabera fusca*.

A small amount of hæmolymph (5–20 μl.) is obtained from the insects by puncturing the ventral side of thorax or abdomen. The light yellow hæmolymph appearing on the wound is sucked up in a capillary pipette, and blown out into a small titration vessel (capacity *c.* 500 μl.) and immediately diluted with distilled water (*c.* 100 μl.). After bringing the mixture to the appropriate *p*H with sodium hydroxide and, in the case of magnesium titration, adding a buffer solution, the indicator is added and titration carried out. Murexide is used as an indicator for the presence of unchelated calcium, whereas eriochrome-black *T* is used to indicate the presence of unchelated magnesium.

As ethylenediamine tetraacetate has a much greater affinity for calcium than for magnesium, the calcium concentration may be calculated from the amount of the reagent used in the murexide titration, whereas the sum of calcium and magnesium can be found by performing an eriochrome-black titration; the magnesium concentration is therefore obtained by subtraction. Calculations are very simple since one mole of ethylenediamine tetraacetate chelates one mole of divalent cation.

The reliability of the method was tested by performing determinations of calcium and magnesium in solutions containing known amounts of calcium chloride and/or magnesium sulphate, in human sera to which known amounts of magnesium sulphate had been added, in samples from pooled hæmolymph, in samples taken successively from the same insect and in hæmolymph to which known amounts of magnesium sulphate had been added. Moreover, the results of micro-titration were compared with those of macro-titration with ethylenediamine tetraacetate and in a few cases with those of the calcium-oxalate precipitation method. The results of these checking experiments were quite satisfactory.

A large number of determinations have been carried out on hæmolymph of single individuals of *Periplaneta americana*, and some for *P. australasiae* and *Blabera fusca* (see Table 1). From these data it may be concluded that the intraspecific as well as the interspecific differences are rather small, especially in the case of calcium. Sex differences are not significant. The ratio calcium/magnesium is about the same for all three species.

Table 1

Species	Calcium* (mgm. per 100 gm. of hæmolymph)	Magnesium* (mgm. per 100 gm. of hæmolymph)	Calcium/magnesium ratio†
P. americana	(107) 17·8+1·9	(83) 13·5+3·0	0·79
P. australasiae	(17) 19·4+2·3	(20) 14·8+4·1	0·79
Blabera fusca	(7) 20·2+2·9	(3) 15·7+2·0	0·77

* Numbers in brackets indicate the number of determinations.
† Calcium and magnesium concentrations expressed in molarities.

As our purpose is to offer a reliable micro-method for the determination of low concentrations of calcium and magnesium in small amounts of biological fluids, it is interesting to compare our results with the few found in the literature. Calcium values are in full agreement with those of Clark and Craig[3]. This, however, is not the case for the magnesium determinations; Clark and Craig found 27·5 mgm. per 100 gm. of hæmolymph, Tobias[4] gives a value of only 7 mgm. per 100 gm. of hæmolymph, both for *P. americana*. In our view the dry-ashing of the hæmolymph as used by both authors may lead to erroneous results, as by this procedure organic phosphorus is converted to possibly interfering inorganic phosphates. However, differences in the animal material may also have played a part, although we do not consider this very probable.

Our experiments permit no conclusion as to the state in which the elements investigated are present.

A more detailed report of our investigations will be published elsewhere.

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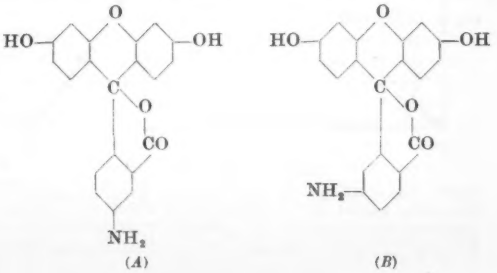
A Chromatographic Separation of the Aminofluorescein Isomers

IN the preparation of aminofluorescein by the condensation of 4-nitrophthalic acid and resorcinol followed by reduction, two isomers (*A*) and (*B*) are formed at the condensation stage, and these must



(*A*) (*B*)

be separated if unequivocal results are to be obtained in the subsequent reaction of the derived fluorescein isocyanate with proteins to give fluorescent protein conjugates[1].

The conventional method of separation of the two isomers consisting of fractional crystallization of the nitrofluorescein diacetates[1] is laborious and wasteful; to obviate this we have devised a chromatographic separation of the two isomers.

A kieselguhr column ('Hyflo-Supercel') is used with 0·2 *M* sodium phosphate buffer *p*H 8·0 (3 ml. of buffer to 5 gm. of kieselguhr) as stationary phase and a mixture of *n*-butanol and *cyclo*hexane as mobile phase. In Fig. 1 is shown the result obtained with a mixture of the aminofluoresceins that had been originally purified as the nitrofluorescein diacetates, using in this case as mobile phase *n*-butanol (65 per cent v/v) and *cyclo*hexane (35 per cent v/v). Peak 1 represents an impurity present in the crystalline aminofluorescein II (using the nomenclature adopted by Coons *et al.*[1]), peak 2 represents aminofluorescein II, peak 3 represents an impurity in the crystalline aminofluorescein I and peak 4 is aminofluorescein I. The time required for the separation was decreased by using gradient elution, the column being started with *n*-butanol (30 per cent v/v) – *cyclo*hexane (70 per cent v/v), and the concentration of *n*-butanol was raised continuously using an apparatus similar to that described by Donaldson *et al.*[2] with the addition of a magnetic stirrer. (Alcoholic alkali was added to the column eluate in order to increase the light absorption of the first two peaks.)

The method was scaled up to deal with larger amounts of material by the use of a column 70 cm. long and 3 cm. in diameter, containing 100 gm. of kieselguhr, attached to an automatic fraction collector. From 365 mgm. of crude aminofluorescein soluble in the column mobile phase, 179 mgm. of aminofluorescein I and 105 mgm. of aminofluorescein II were obtained, the impurities (peaks 1 and 3) running as separate bands being discarded. This gave yields based on the original nitrofluorescein of 36·2 per cent of aminofluorescein I and 21·2 per cent of aminofluorescein II (reduced to 23 and 14·3 per cent respectively after crystallization), whereas the use of fractional crystallization as the separation technique gave only 11·7 per cent of aminofluorescein I and 4 per cent of aminofluorescein II. The purity of the fractions obtained from the large column was checked by comparing them with those obtained by fractional crystallization by means of a paper chromatogram.

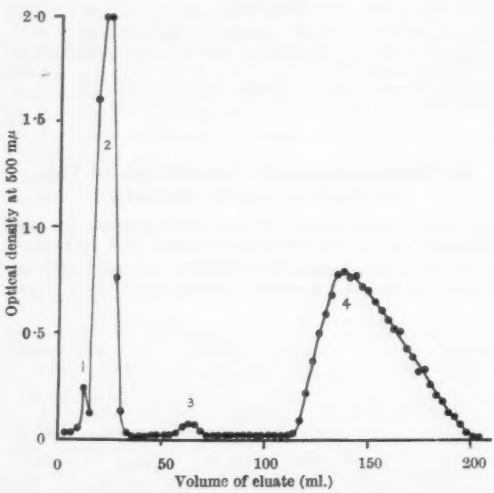


Fig. 1. Chromatogram run with a mixture of the two aminofluoresceins purified as the nitrofluorescein diacetates; mobile phase, *n*-butanol (65 per cent v/v) – *cyclo*hexane (35 per cent v/v). Peak 1, impurity present in aminofluorescein II; peak 2, aminofluorescein II; peak 3, impurity present in aminofluorescein I; peak 4, aminofluorescein I

Although this chromatographic technique is not suitable for very large quantities of material, the fact that only a few milligrams of aminofluorescein is required at any one time makes chromatography particularly suitable for the separation of the aminofluorescein isomers.

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Ability of Normal and Sickle-Cell Hæmoglobins to form Complexes

The electrophoretic examination of hæmoglobin samples from Africans with sickle-cell trait, collected by one of us (Griffiths[1]), showed that the mobilities were not constant and did not agree with values reported by other observers (for example, Pauling *et al.*[2]). Among nine specimens we found values ranging from $-1\cdot6$ to $-3\cdot0 \times 10^{-5}$ cm./sec./V./cm. for the normal hæmoglobin component and from $-1\cdot2$ to $-2\cdot4 \times 10^{-5}$ cm./sec./V./cm. for the sickle-cell component. Seven normal hæmoglobin samples gave values between $-1\cdot7$ and $-3\cdot8 \times 10^{-5}$ cm./sec./V./cm. Not only did the mobility vary from individual to individual, but also samples taken from one subject varied from time to time. The values were all determined by electrophoresis in the Tiselius apparatus at a concentration of about 1·5 per cent of hæmoglobin, prepared by Drabkin's method[3], in phosphate buffer at *p*H 7·5 and ionic strength 0·1. Similar variations in mobility were shown by paper electrophoresis. The variations were not due to technical errors, because replicate determinations with a given specimen of blood gave concordant results. The absence of methæmoglobin or similar derivatives was shown by spectroscopic examination.

Many workers have reported that normal hæmoglobin can be resolved into fractions with differences in solubility, resistance to alkaline denaturation and gel formation. It is possible that the differences in electrophoretic mobility described here are a reflexion of such heterogeneity.

Usually the proportions of normal and sickle hæmoglobin components were reversed in the ascending and descending columns; a typical example is shown in Table 1. This reversal is the same as that found by Longsworth and McInnes[4] on electrophoresis of albumin – nucleic acid complexes. Jayle *et al.*[5] state that hæmoglobin forms a complex with haptoglobin, and Cheesman[6] showed that a complex is formed between hæmoglobin and ribonucleic acid. These facts suggested to us that such complex formation between hæmoglobin and some other constituent of the red cells might be responsible for the different mobilities observed, and that sickle-cell hæmoglobin

Table 1. Mobilities and Proportions of Normal and Sickle Components in Sickle-Cell Trait Hæmoglobin

Components	Mobility (cm./sec./V./cm. × 10^5)	Proportion of total	
		Ascending (per cent)	Descending (per cent)
Sickle-cell hæmoglobin	2·3	54·0	32·1
Normal hæmoglobin	2·8	46·0	67·9

Table 2. Mobilities of Hæmoglobin Complexes

Mixture	Mobilities (cm./sec./V./cm. × 10^5)			
	Ascending		Descending	
	Slow	Fast	Slow	Fast
Hæmoglobin	2·1	—	2·0	—
Nucleic acid	16·5	20·0	16·9	—
Hæmoglobin + nucleic acid	2·5	19·9	•2·2	17·6
Carbonic anhydrase	—	2·6	—	2·6
Hæmoglobin + carbonic anhydrase	1·1	1·6	1·1	1·6

might differ from normal hæmoglobin in being such a complex with some unidentified macromolecule.

To test the feasibility of this hypothesis, normal hæmoglobin was mixed with nucleic acid and the mixture dialysed against phosphate buffer and submitted to electrophoresis. The mobility of the original hæmoglobin was altered and a new peak, presumably corresponding to a hæmoglobin – nucleic acid complex, appeared (Table 2). Mixtures of carbonic anhydrase and hæmoglobin gave similar results, whereas globin – hæmoglobin mixtures gave three peaks. Reversal of the proportions of the components in the ascending and descending columns was also noted.

A corollary of this suggestion is that, if two samples of sickle-cell trait hæmoglobin with different mobilities are mixed and submitted to dialysis and electrophoresis, the original complexes may dissociate and then recombine to give two fresh peaks with mobilities intermediate between those observed in the separate samples, due to rearrangement between the sickle-cell and normal hæmoglobin components. Alternatively, if the original complexes are more firmly bound, the mixture of the two samples might give rise to four peaks with unaltered, or only slightly altered, mobilities and areas. We have found both sorts of result in such tests.

These results suggest that the abnormal hæmoglobins which have been described may not, in fact, be actual different hæmoglobins but complexes of normal hæmoglobin with some other macromolecule which is constantly present and genetically inherited, and which, in some instances, may so alter the solubility properties of the hæmoglobin as to give rise to the 'sickle' phenomenon.

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Hæmolytic Anæmia produced Experimentally in the Guinea Pig by *T*-transformation of the Erythrocytes *in vivo* with Purified Concentrated Enzyme

During the continuation of work aimed at explaining the development and possible significance of the Thomsen phenomenon[1] *in vivo* (so-called polyagglutinability), it proved practicable to produce hæmolytic anæmia in guinea pigs by *T*-transformation of their erythrocytes *in vivo*. The term '*T*-transformation' applies to the production of the specific receptor-*T* in erythrocytes through the activity of an enzyme formed by various bacterial species[1].

In a preceding communication[2], it was described how *T*-transformation of the erythrocytes of guinea pigs *in vivo* can be induced by infecting animals with pneumococci. It has been found that *T*-transformation of the erythrocytes may also appear in guinea pigs in the course of spontaneous infection with *pnc.* 19. Furthermore, *T*-transformation *in vivo* can also be produced by giving animals intravenous injections of a solution of enzyme from *pnc.* 19. The present work was carried out with concentrated enzyme prepared by elution of the enzyme, combined with erythrocytes, on the lines described by Burnet *et al.*[3].

The investigation was commenced with several animals, but unfortunately some died early from irrelevant causes so that eventually only four experimental animals were available. The result appears so clear-cut, however, that its publication is thought to be of interest. As a matter of fact, in various ways, it has been confirmed by other experiments now proceeding.

The four animals were uniform as to size, age, sex and colour. Initially the amount of hæmoglobin, erythrocyte count and reticulocyte count were determined; and, for some time, the urine had been examined daily by the benzidine test and was found to be free from blood. The anti-*T* content of the serum was found to be considerable in two of the animals, but low in the other two.

In the two animals with high anti-*T* titre the erythrocytes were now *T*-transformed by intravenous injection of concentrated enzyme. The other two animals were given injections of the same amounts of saline, and they served as controls. Then, on every other day, hæmoglobin determination as well as erythrocyte and reticulocyte counts were carried out on all the animals. On every other day the erythrocytes were examined for *T*-transformation. The urine was examined daily for the presence of hæmoglobin. The animals—the *T*-transformed as well as the controls—suffered a loss of blood amounting to ½–1 c.c. every other day. (The blood was taken from the ear as capillary blood, not withdrawn by heart puncture as the latter would have entailed a risk of internal hæmorrhage.)

In one of the animals whose erythrocytes were *T*-transformed, in the course of three days the hæmoglobin fell from 84 to 43 per cent; in the other animal of this group it fell in seven days from 99 to 46 per cent. The erythrocyte content showed a corresponding fall. The presence of hæmoglobin in the urine could be demonstrated in these animals during the first two days. No positive benzidine reaction could be ascertained in any of the other cases. The controls showed a fall in hæmoglobin from 91 to 90 and from 86 to 79 per cent, respectively, which corresponds to the presumably small loss of blood through sampling of the blood.

The two animals in which anæmia was produced were pale and weak, but icterus was not ascertained at any time. During the following two to three weeks, the hæmoglobin percentage and erythrocyte count rose again to normal values. In all the animals the fall in hæmoglobin was followed by a transitory increase in reticulocytes in the peripheral blood. Thus, in the two animals with pronounced fall in hæmoglobin, the reticulocyte count rose respectively from 0·2 and 0·4 per cent before the injection of enzyme to 17·8 and 19·0 per cent nine days after.

For the two controls the increase in the reticulocyte count was from 0·6 and 0·0 to 2·4 and 3·0, respectively.

The experiments described above will be reported in detail elsewhere.

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Isolation of Mucic Acid from Fruits

Mucic acid has only been recorded twice as occurring in natural products, namely, in putrified blood[1] and in the diffusion juice from sugar beet[2]. Pure mucic acid has now been isolated from sound ripe peaches and pears by methods which make it appear certain that the acid was present in the free state in the fresh fruit.

The extraction and separation of the acids was carried out as described previously[3], except that the solution of acid and sugars (after removal of the bases and amino-acids with a cation-exchanger) was run straight on to a column of a strong-base anion-exchanger in the acetate form. This column was placed above two or more smaller columns of the same resin in the acetate form, and the acids were displaced with 0·1 *N* hydrochloric acid. Paper chromatograms of the fraction(s) between the malic and citric acid bands contained an acid with $R_F = 0$ in methyl ethyl ketone – cineole – aqueous formic acid (53 per cent w/v) (50 : 50 : 36 v/v)[3], and $R_{malic} = 0·9$ in alcohol – ammonia – water (80 : 5 : 15)[4]. The isolated acid and mucic acid behaved identically on paper chromatograms and ion-exchange columns. The acids were revealed by rapidly pulling the paper through a solution of silver nitrate in acetone, followed by (*a*) heating the paper for a few minutes at about 100° C., and then (*b*) spraying it with alcoholic sodium hydroxide (cf. ref. 5). The chromatogram was then fixed with sodium thiosulphate (5 per cent). After treatment (*a*), all acids gave a white spot; after (*b*) acids having an α,β-glycol or an α-keto group gave an intense black spot on a grey background.

When the fractions containing mucic acid were allowed to stand at + 1°, crystals separated. Recrystallization from sodium hydroxide – hydrochloric acid yielded an optically inactive acid of melting point 215° (decomp.)[6], not depressed by authentic mucic acid. The diphenylhydrazide had melting point 242°[6]. The acid from peaches gave on analysis C, 34·2; H, 4·8; O, 61·0; that from pears C, 34·1; H, 4·9; calc. for $C_6H_{10}O_8$: C, 34·3; H, 4·8; O, 60·9 per cent. About 100 mgm. of mucic acid was isolated from 2 kgm. of ripe peaches or pears. Apricots, passion fruit and blackberries probably contain mucic acid in variable amounts, since crystalline precipitates, melting point 214–215°, were isolated from them by the same method.

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Effect of Silver Ions on Mitochondrial Adenosine Triphosphatase

Abood, Gerard and Ochs[1] claim that the respiration of cell-free dispersions and mitochondria of brain tissue was increased by the passage of electrical impulses between silver electrodes in the suspension medium. In general, increase in the respiratory rate of well-prepared mitochondria is consequent upon increase in the rate of removal of adenosine triphosphate, by addition of systems which catalyse its dephosphorylation, or through activation of the mitochondrial adenosine triphosphatase[2]. We were thus led to test the effect of electrical impulses on the adenosine triphosphatase activity of mitochondria, obtained from rabbit cerebral cortex, using the medium which had enabled the preparation of mitochondria of low initial adenosine triphosphatase activity from pigeon breast muscle[2]. For the adenosine triphosphatase assays the particles were incubated for 10 min. at 20° in a medium of the following approximate composition: 0·1 *M* potassium chloride, 0·05 *M* amino*tris*hydroxymethylmethane-hydrochloride buffer *p*H 7·4, 0·005 *M* magnesium sulphate, 0·005–0·0075 *M* sodium adenosine triphosphate, and 5×10^{-5} *M* ethylenediaminetetraacetate. With 0·0075 *M* adenosine triphosphate, mitochondria from 60 mgm. of tissue liberated about 20 μgm. of inorganic phosphate under these conditions, and the activity was increased three-fold on addition of 10^{-4} *M* 2 : 4-dinitrophenol.

Electrical impulses (2–3 V., 25–75 m.amp., 50 c./sec.) were applied during the incubation through dipping electrodes (type *G* of Ayres and McIlwain[3]). With gold and molybdenum electrodes, there was no effect on the adenosine triphosphatase activity; but with silver electrodes the rate of phosphate liberation increased two- to three-fold. However, the mere presence of the silver electrode, without passage of current, or addition of low concentrations (10^{-6} to 10^{-5} *M*) of silver nitrate, led to similar increases in adenosine triphosphatase activity.

In a paper[5] which appeared after the conclusion of these experiments, Narayanaswami and McIlwain state that pulses from molybdenum electrodes did not affect adenosine triphosphatase activity of dispersions of cerebral tissue, and, indeed, caused only a small increase in the respiration of brain mitochondria. Our experiments, however, disclosed the stimulation of mitochondrial adenosine triphosphatase by silver ions; and, since dinitrophenol also has this effect, it was of interest to determine whether silver ions behave similarly to dinitrophenol in other

systems. The adenosine triphosphatase activity of pigeon breast muscle mitochondria was increased some five times by 10^{-5} *M* silver nitrate (optimal concentration). The reversal of the spontaneous swelling of muscle mitochondria *in vitro* by adenosine triphosphate, an action inhibited by dinitrophenol[3], was also inhibited by low concentrations of silver nitrate; brain mitochondria behaved similarly. On the other hand, the calcium-activated adenosine triphosphatase of myosin, which is stimulated by dinitrophenol[4] in rather high concentrations (for example, 60 per cent acceleration at 2×10^{-3} *M* [5]), is not stimulated by silver ions; under our conditions (*p*H 7·0, L-myosin 17 μgm. nitrogen/ml.) there was inhibition above 3×10^{-6} *M* silver ions (cf. ref. 8), and no acceleration at lower concentrations down to 10^{-7} *M*.

If silver ions stimulate adenosine triphosphatase activity of mitochondria, they might be expected to accelerate their respiration. Abood *et al.*[1] found no effect of 10^{-5} *M* silver ions on the respiration of brain dispersions; but we observed, with pyruvate together with malate as substrates, about 200 per cent acceleration of the respiration of brain mitochondria by 5×10^{-6} *M* silver nitrate.

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Electrolyte Concentrations in Red Blood Cells of British Breeds of Sheep

During preliminary experiments on the electrolyte balance of adrenalectomized Scottish Blackface ewes, it became apparent that the concentrations of potassium and sodium in the red blood cells in this breed were not constant. Further examination revealed that they fell into two distinct groups in phenotypically similar animals.

This observation has now been extended to a larger sample of the breed. As the plasma sodium and potassium concentrations were the same in the two groups, a photometric examination of the whole blood enabled a satisfactory separation of the two electrolyte types to be made. It was found that the whole-blood sodium concentration varied inversely with that of the potassium. A separation into the two electrolyte types using sodium concentrations alone was not possible, however. Results are plotted in Fig. 1.

Ninety-three Scottish Blackface sheep were examined: eighty for both potassium and sodium and thirteen for potassium only. Of these, forty-seven were shown to belong to a type in which the concentration of potassium ranged about a mean value of 36 m.equiv./l., whereas forty-six belonged to a group which ranged about a mean of 13 m.equiv./l. These will be referred to as type *HK* and type *LK* respectively.

Sodium and potassium determinations were made on both plasma and whole blood in sixteen of these Blackface sheep—eight of each type—together with hæmatocrit readings. The red cells, by difference, were calculated to contain mean values of 34 and 80 m.equiv./l. sodium and mean values of 89 and 24 m.equiv./l. potassium.

As a 1 : 1 ratio for *HK* and *LK* types of sheep had not been reported previously, it was decided to examine another breed to see if this ratio was peculiar to the Scottish Blackface sheep or whether the ratio varied from breed to breed. A total of forty-three Cheviots was examined, thirty-nine for both potassium and sodium and four for potassium only. Of these, seven were shown to belong to the *HK* type and thirty-six to the *LK* type.

While this work was in progress, Widdas[2] published the results of an examination of twenty-two pregnant Welsh ewes, in which he found eight animals to belong to the *HK* type and fourteen to the *LK* type.

It is clear that, so far as the concentrations of sodium and potassium in the red cells are concerned in the three breeds examined, two types exist, and the distribution between groups varies from breed to breed.

The majority of merino sheep[1] appear to belong to the type *LK*, whereas representatives of both types have been recorded together with intermediate types in the Lebanese fat-tailed sheep[2]. It is intended to examine further the percentage distribution of the two types already recognized in the British breeds of sheep and to see whether intermediate types exist. Should the homogeneity of the merino and the heterogeneity of the fat-tailed sheep be confirmed when larger numbers are examined, there may then exist a method for a further study of the evolution and migration of the Ovidae. [The role of electro-

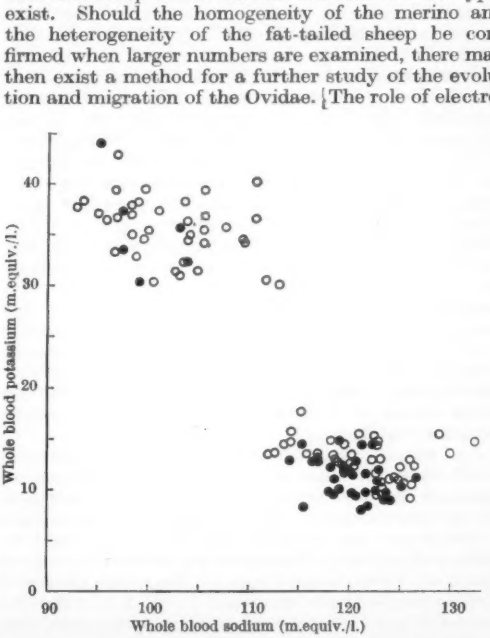

Fig. 1. Concentrations of sodium and potassium in the whole blood of Scottish Blackface (○) and Cheviot sheep (●)

lytes, and particularly of sodium and potassium, in the reaction of the body to unfavourable circumstances, suggests that it is important to determine whether there is any fundamental difference in the reaction of these two distinct types of sheep.

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Storage of Plant Mitochondria

One of the difficulties encountered in the purification of many plant enzymes is their low concentration in the intact cell. When enzymes are contained in the mitochondria, considerable concentration of such enzymes can be achieved by using isolated mitochondria as the starting material for further purification. An example of this approach is the purification of the acetate-activating enzyme of beef heart[1]. Millerd and Bonner[2] have pointed out that the difficulty in using this method in the case of plants is that no convenient sources exist for the isolation of large quantities of plant mitochondria. It has now been found that plant mitochondrial suspensions may be stored in the frozen state for at least thirty days. Although the activity of the mitochondria gradually decreases, the ability to store such suspensions makes possible the accumulation of relatively large quantities of material which can then be used for the isolation of specific enzymes.

Seeds of Algerian oats, *Avena sterilis* (L.) Mal. s. sp. *byzantina* (C. Koch) Thell., were soaked in water for 2 hr. and sown in moist vermiculite. They were grown in the dark at 26·6° C. for 6 days. At this stage, the above-ground portions of the plants, representing the coleoptiles, first leaves and first internodes, were about 6 cm. high. Mitochondria were prepared from the above-ground portions of the plants as previously described[3], using 0·5 *M* sucrose–0·01 *M* ethylenediaminetetraacetic acid, *p*H 7·0, as the homogenizing medium. The mitochondria were freed of ethylenediaminetetraacetic acid by suspension in 0·5 *M* sucrose and recentrifugation. The washed pellet was suspended in 0·5 *M* sucrose and the volume adjusted so that the nitrogen content of the suspension was 0·6–1·0 mgm. per 0·5 ml. The suspension was divided into 3–5 ml. portions and stored in 25-ml. Erlenmeyer flasks at approximately − 19° C. The mitochondria were assayed immediately after preparation and after various periods of storage. Thawing was accomplished by swirling the flasks for about 45 sec. in a constant-temperature bath maintained at 30° C.

The rate of oxidation of pyruvate in the presence of catalytic amounts of succinate was taken as an index of the activity of the mitochondria. Oxygen uptake was measured manometrically by the method of Warburg[4], and nitrogen was determined as previously described[3]. Results of representative experiments are presented in Table 1. The values given are for the total oxygen consumed in 60 min. and were corrected for the endogenous oxygen uptake. The rates of oxygen uptake were linear for 60 min. when the mitochondria were assayed immediately after preparation; but after storage, the rates usually declined somewhat during the second 30-min. period. The endogenous oxygen consumption, and the consumption in the presence of 0·001 *M* succinate, were of the order of 16 and 28 per cent respectively of the oxygen uptake in the presence of pyruvate plus succinate.

Table 1. Oxidation of Pyruvate by *Avena* Mitochondrial Suspensions after Various Periods of Storage in the Frozen State. Final concentration of reagents: phosphate buffer (KH_2PO_4-K_2HPO_4) at *p*H 7·3, 2×10^{-2} *M*; magnesium chloride, 2×10^{-3} *M*; adenosine triphosphate, 10^{-2} *M*; diphosphopyridine nucleotide, 10^{-4} *M*; sucrose, 0·4 *M*; pyruvate, 2×10^{-2} *M*; succinate, 10^{-3} *M*; enzyme suspension, 0·5 ml. Final volume, 3·0 ml.; 0·2 ml. 10 per cent potassium hydroxide in side-arm. Gas phase, air. Temperature, 30° C.

Exp.	mgm. Nitrogen per 0·5 ml. mitochondrial suspension	Storage in days	mm.³ Oxygen absorbed per mgm. nitrogen in 60 min.
1	0·97	0	124
		8	101
		12	100
2	0·64	0	178
		21	92
		30	70
3	0·75	0	130
		23	79

In Fig. 1, the relative activity of the mitochondria is plotted as a function of the length of storage. The initial activity of a suspension was taken as 100. From these results, it appears that *Avena* mitochondria retain about 50 per cent of their initial activity after 25 days in storage at − 19° C. During this length of time, it is possible to accumulate large quantities of mitochondria.

The rapidity with which the mitochondrial suspensions are thawed appears to be a critical factor in the maintenance of activity. The results of two experiments to determine the effect of rapidity of thawing on the activity of mitochondrial suspensions are presented in Table 2. Rapid thawing at 2° and at 30° C. gave equally active preparations; but considerable loss of activity occurred when suspensions were thawed slowly at 2° C. After standing at 2° C. for 20 hr., even freshly prepared mitochondrial suspensions were completely inactive.

Experiments are in progress to determine the sensitivity of individual mitochondrial enzymes to low-temperature storage, and also the optimum conditions for storage.

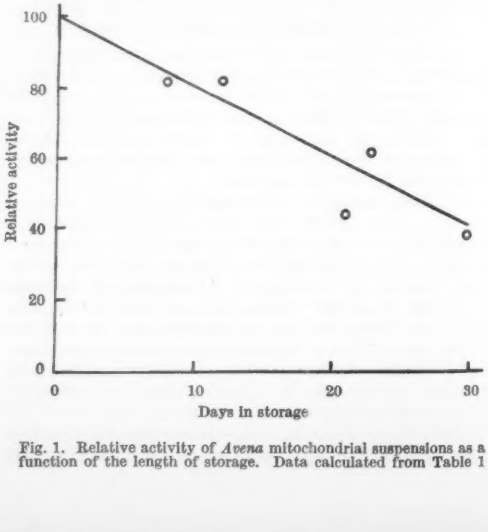

Fig. 1. Relative activity of *Avena* mitochondrial suspensions as a function of the length of storage. Data calculated from Table 1

Table 2. EFFECT OF RAPIDITY OF THAWING ON THE ACTIVITY OF *Avena* MITOCHONDRIAL SUSPENSIONS AFTER STORAGE IN THE FROZEN STATE. Addenda as for Table 1. Exp. 1: 0·60 mgm. nitrogen per 0·5 ml. mitochondrial suspension. Exp. 2: 0·48 mgm. nitrogen per 0·5 ml. mitochondrial suspension

Exp.	Storage in days	Conditions of thawing	mm.³ Oxygen absorbed per mgm. nitrogen in 60 min.	Relative activity
1	0	—	226	100
	1	30 sec. at 30° C.	261	115
	1	5 min. at 2° C.	249	110
	1	2 hr. at 2° C.	133	59
2	0	—	272	100
	2	30 sec. at 30° C.	303	111
		6 min. at 2° C.	270	99
		5 hr. at 2° C.	161	59

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Effect of Thyroxine on Sexual Behaviour in the Ewe

THE administration of thyroprotein to female rats caused an increase in weight of the ovaries, with histological evidence of intense luteinization[1]. It was found that iodinated casein proved beneficial in improving libido and fertility in inactive bulls. It has also been found to overcome 'summer sterility' in rams[2]. So far, little work has been carried out to investigate the effect of thyroxine on the various reproductive processes in the ewe.

In an experiment conducted at the Animal Research Station, Cambridge, to investigate the effect of orally administered L-thyroxine on wool production in the ewe, nineteen ewe lambs were used. Five of them were given L-thyroxine in gelatin capsules daily for eleven months from August 15, 1952, to July 17, 1953. For the first six weeks the dosage was 3·5 mgm.; it was raised to 5 mgm. for the next six months and then maintained at 4·5 mgm. for the last three and a half months. After two months of the cessation of thyroxine administration and at the beginning of the breeding season (October 1953), when the treated ewes were allowed to run with the ram, they exhibited hyper-sexual activities characteristic of male behaviour, namely, jumping and mounting other animals. These symptoms took place at the normal breeding season. It appears that an intensification of the normal œstrous behaviour took place at about the time of ovulation. However, these ewes were served and lambed as normal.

Another experiment was conducted to investigate this effect and also the possibility of bringing the ewes on heat during the anœstrous period. Of ten ewes, five were fed daily 7 mgm. L-thyroxine from April 1 to May 20, 1954, the other five being used as controls. They were running continuously with a vasectomized ram. The ram's briskets were ochred daily and the ochre colour was changed every fourteen days. Observations for œstrous were carried out daily. None of the treated ewes was served by the ram. However, two ewes showed the same type of hyper-sexual activity as had been observed previously. The two ewes did not attract the attention of the ram running with them, and neither did the other ewes. The ram was changed and replaced by another ram known to have recently served artificially œstrous ewes, but this ram also did not serve the two ewes. Moreover, the two ewes did not show normal œstrous periodicity. They were active intermittently, with never more than four or five days rest. Laparotomy was performed on the more active of the two ewes the day after it was observed to be active. Both ovaries were very small and showed no sign of follicular activity. These observations seem to be a more abnormal type of behaviour not linked to ovarian activity. Perhaps the best way to explain these results would be to attribute this behaviour to an effect on the central nervous system. It is well known that, in the human, hyperthyroid individuals tend to be over-excitable.

J. Hammond, jun.[3], observed jumping on other ewes by an anœstrous ewe injected with stilbœstrol. He also observed it once in a normal ewe at œstrous and often in normally œstrous ewes after stilbœstrol injection (personal communication). He offered the opinion that such male behaviour seems to be due to prolonged stimulation rather than to heavy dosage of œstrogen. However, there is no evidence that in the animals treated with thyroxine œstrogen secretion was at all enhanced.

So far as bovine fertility is concerned, it is of great importance to have a wider knowledge of the effects of hyperthyroidism induced by the administration of thyroxine on ovulation and implantation of the fertilized ova.

I am indebted to Dr. John Hammond for his guidance and advice, and to Mr. J. Hammond, jun., for suggestions during the course of the present investigations.

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Phenetidine in Urine

THE urinary substance referred to as *B* in a previous communication[1] has now been isolated in pure form. It can be shown to be *p*-phenetidine by its infra-red and ultra-violet spectra, the melting point of a picrate (176–180° C.) and lack of depression of melting point in a mixture with authentic *p*-phenetidine picrate (179–181° C.). It is present in urine as a labile acidic substance which can be precipitated by lead acetate and purified by paper chromatography from butanol–acetic acid (R_F about 0·5). The precursor seems to be a conjugate with sulphuric acid. About 2–3 per cent of administered phenacetine is excreted in this form.

Substance *B* was believed to be a tryptophan metabolite because a compound with the melting

point of quinaldic acid was isolated from the urinary concentrates, and spectroscopic evidence for a derivative was compatible with *o*-aminobenzyl alcohol until comparison with authentic samples became possible. Numerous compounds with similar ultra-violet spectra could be differentiated using the characteristic shifts of the absorption maxima in three solvents: 0·05 *N* hydrochloric acid, 0·1 *N* ammonia and ethylether.

The reported biological relationship of substance *B* (*p*-phenetidine) can be explained by (*a*) suppression of kynurenine excretion by some constituent of the antipyretic–analgesic mixtures containing phenacetine. Phenacetine itself fails to suppress the excretion of kynurenine. The second factor (*b*) seems to be increased need of analgesics in patients on a meat-free diet. The occurrence of phenetidine in apparently healthy people may be an index of self-medication (about 10 per cent).

Thanks are due to the National Cancer Institute of Canada for financial assistance, and to Drs. J. Patrick and K. Wiesner for samples of *o*-aminophenylmethylcarbinol and *o*-aminobenzylalcohol, respectively.

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Chromosomal Biotypes in Emmer Wheat

The emmer wheat (*Triticum dicoccum* Schrank) and some of its varieties are known for their resistance to black rust, and the Indian emmer or khapli is extensively used in breeding rust-resistant varieties. It is usually grown in Central and Southern India and is commonly known as khapli wheat; botanically it is *Triticum dicoccum* Schrank var. *farrum* Bayle. According to Percival[1], the Indian and Abyssinian emmers have had a common origin and both are allied to *T. dicoccum* Schrank var. *ajar* Percival.

In a collection of the Indian emmer wheats (khapli) at the Indian Agricultural Research Institute, New Delhi, two distinct races have been discovered differing from each other with respect to certain characters. These are shown in Table 1.

The two types also differ cytologically in having either one or two pairs of *SAT*-chromosomes. As is well known, all the tetraploid wheats ($2n = 28$), including *T. dicoccum*, have two pairs of *SAT*-chromosomes, whereas these types, provisionally called biotypes 1 and 2, breed true to their chromosome type, that is, the number of *SAT*-chromosomes (Fig. 1). So far as we know, such chromosomal biotypes have not been hitherto reported in emmer wheat and perhaps also not in other species of the genus *Triticum*. In barley, however, chromosomal biotypes have been recently reported by Hagberg and Tjio[2].

Table 1

Characters	Biotype 1	Biotype 2
Length of ear	13·0 cm.	9·0 cm.
Pollen size	44·5–64·7 μ	48·0–63·0 μ
Pollen fertility	79·0 per cent	97·4 per cent
Grain-setting	67·5 per cent	90·0 per cent
Grain size	9·0 mm. long 2·5 mm. wide	8·0 mm. long 2·3 mm. wide

Fig. 1. *T. dicoccum* Schrank; $2n = 28$, with only one pair of *SAT*-chromosomes

Fertility and grain-setting in interspecific crosses between khapli (*T. dicoccum*) and bread wheat (*T. aestivum*) have been variously reported by different workers. Haynes[3] succeeded in getting fertile F_1 plants in reciprocal crosses between "Federation" and khapli. In crosses between "Garra", "Steinwedel" and khapli, Waterhouse[4] obtained as high as 65 per cent of grain-setting. Pal[5] has reported the F_1 hybrids between khapli and bread wheat to be "fairly highly fertile", while Bhatia[6] has recorded some seed-setting in similar crosses, but his F_1 plants did not grow to maturity. Recent observations at this Institute, however, have given almost the opposite results. Crosses made between khapli and bread wheat have given consistently highly sterile F_1 plants. This confirms the observations made earlier by Hayes and Stakman[7]. In view of the occurrence in Nature of two chromosomal biotypes of khapli, differing in their relative fertility, such variation in the fertility of F_1 hybrids, as observed by previous workers, is not only possible but also significant. Further studies on the behaviour of the hybrids of the two biotypes of khapli and types of *Triticum aestivum* in various combinations are likely to throw much light on: (i) the problem of relative fertility of the hybrids; and (ii) the relative resistance of the hybrids to the different races of black-rust.

We thank Dr. B. P. Pal, director, and Dr. R. D. Asana, head of the Division of Botany, Indian Agricultural Research Institute, New Delhi, for giving the material and facilities to conduct the present investigation.

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A Supernumerary Pelvic Fin in the Powan (*Coregonus clupeoides* Lacépede)

An abnormal pelvic structure in the form of an additional median fin (Fig. 1) was first observed in the powan during field studies on the population of this species of whitefish in Loch Lomond in 1951. Between 1951 and 1953 eighteen fish, representing 1·5 per cent of the total number examined, were found to have this abnormality; its occurrence is independent of sex of the fish or of their regional location in the lake. All these fish were two or more years old, but one specimen reared in the laboratory showed that the structure first appears at the age of about six months.

The additional fin occupied the same position in all specimens, lying in a median vertical plane with its base set symmetrically between and slightly in front of the bases of the paired pelvic fins. Externally, it projected from the ventral surface to an extent which varied widely without relation to size of fish. In its smallest form it appeared as a mere knob 2 mm. in length, in better developed forms as a translucent and rigid spike or blade and in the most highly developed example it was three-quarters of the length of the pelvic fin, flexible and with dark pigmentation towards the free edge.

The skeletal features of the abnormal specimens were examined initially by radiography and some visually after staining with alizarin red for bone or victoria blue for cartilage and clearing. The skeleton of a well-developed additional fin consisted of a pair of small anterior bones, presumably the elements of a fin ray, behind which there were nine separate rays, long and halved, with their bases enlarged. The stems of the rays were jointed and branched distally into tapering filaments as in normal lepidotrichia. The ray bases were hinged to an elongate structure of bone and cartilage consisting of an anterior and a posterior element closely apposed. The anterior and larger element possessed lateral cartilages with which the inner surfaces of the half-rays articulated, and the hind end of the posterior element lay just in front, and quite independent of, the median symphysis of the broad posterior part of the normal pelvic bones. As there were no other bones in the abnormal structure, these two elements may correspond to radial bones. They had a shallow seating on the median ventral tendon connecting the protractor and retractor ischial muscles to the pelvic arch but appeared to have no connexion with this tendon, being held in position by connective tissue only. No muscles appeared to be associated with the abnormal fin, and the muscles serving the paired pelvic fins were similar to those in normal powan.

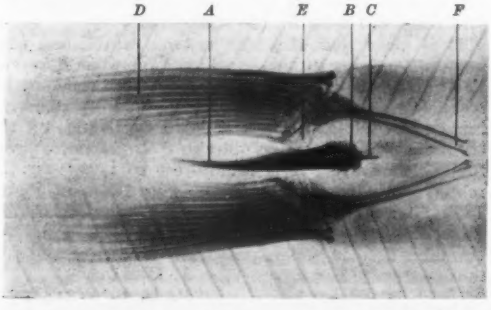

Fig. 1. X-ray positive of supernumerary fin, ventral view. *A*, Flexible rays; and *B*, their massive bases; *C*, bony projection of anterior element of supporting structure; *D*, normal pelvic fin (right); *E*, broad post-mesiad part of pelvic bone (right); and *F*, its elongate anterior end

The average complement of rays and their pattern was the same in the paired fins of normal fish and those with the additional median fin. This fin therefore does not appear to have been derived from elements of the pelvics or to be connected in any way with them. It may be regarded as a true supernumerary fin the origin of which is uncertain. A more detailed description of its structure will be given elsewhere.

The occurrence of an additional fin in the pelvic region is now known to be present in two other members of the genus *Coregonus*. It has been reported (M. Dottrens, personal communication, 1953) to exist in approximately one per cent of the population of whitefish in Lac de Thoune, Switzerland, in a variety of *Coregonus wartmanni* known as the albock. In 1953 a similar abnormality was discovered in one of sixty specimens of the schelly (*Coregonus clupeoides stigmaticus*) from Ullswater in the English Lake District (G. J. Thompson, personal communication, 1953). The powan and schelly belong to the same British species and *C. wartmanni* is generally considered to be their closest relation among the numerous coregonid fishes in the continent of Europe. Since this abnormality has appeared in three isolated populations, further study may reveal whether it is attributable to a mutant genetic factor in this particular group of coregonids or in the genus as a whole. If it is restricted to the former, then it may provide a clue to their distribution in the Old World.

My thanks are due to Prof. C. M. Yonge and to Dr. H. D. Slack for their support and assistance, and to Dr. E. Trewavas, curator of fishes in the British Museum (Natural History), for technical advice.

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A Curious Ecological 'Niche' among the Fishes of Lake Tanganyika

Previous studies on certain Tanganyika Cichlids[1] have shown that, in species of the genus *Plecodus*, the stomach content is often composed of fish scales. It was not known if this was an indication of a very peculiar diet, and whether these scales had been taken from live or dead fish.

By collecting live and dead specimens of *Plecodus straeleni* Poll, *Plecodus paradoxus* Boulenger and a dead specimen of a *Pl. elaviae*, we are in a position to answer these questions. In one dead specimen of *Pl. straeleni* we have found the stomach full of ctenoid scales and in another one, of *Pl. paradoxus*, the stomach was full of Cichlid and Cyprinid scales, and did not contain any other food. In an aquarium we have been able to observe two *Pl. straeleni* feeding on the scales of a new species of *Lamprologus*, on those of *Lamprologus compressiceps* and of *Callochromis macrops*, all of which are bigger than the *Plecodus*.

It seems very difficult to feed *Pl. paradoxus* on earthworms, fish powder or insects. As for *Pl. straeleni*, we have been unable to feed them on any-

Fig. 1. *Plecodus paradoxus* Blgr. Dentition and isolated tooth (lateral view) after Poll (1948)

thing other than scales of live fish. When a *Plecodus* succeeds in attacking a fish, it pushes its mouth against the back of its victim for a short while. Then it swims away, leaving a denuded spot.

In the aquarium it seems that some species of fish know how to escape the attack of *Plecodus*, and they are able to drive them away from their shelter. For example, we have never seen a *Plecodus* 'scaling' a *Lamprologus savoryi* Poll, though a frequent fish in the *Plecodus*' environment, or a *Lobochilotes labiatus* or a *Simochromis curvifrons*. Some other fishes swim away from a *Plecodus* as soon as it appears (for example, *Lamprichthys tanganicanus*).

Of the four species of *Plecodus* (*Pl. paradoxus, straeleni, elaviae, multidentatus*) the first three were caught above a rocky bottom, the fourth one, above a muddy bottom, at considerable depth (90 m.). The first two are more littoral than *Pl. elaviae*. Sometimes, native fishermen catch *Pl. paradoxus* and *elaviae* with lines, baited with pieces of a small fish (*Stolothrissa tanganicae*). Thus it seems that adult *Plecodus* may secondarily turn to true carnivorous habits.

This peculiar way of feeding, so far as we know, has not been described in any marine fish, and the problem is how it has evolved from typical voracious habits. However, the dentition of *Plecodus*, with powerful band-like teeth, bending backwards (Fig. 1), seems, as Poll's figures show it, to be well adapted to that particular diet.

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Occurrence of a Species of *Ornithodoros* in Britain

While visiting Puffin Island, at the north-east end of the Menai Straits (North Wales) on May 16, 1954, about a dozen specimens of an argasid tick consisting of late nymphal stages and adults of both sexes were collected from under a stone in a dry part of the cliff. They possessed the movable cheeks to the camerostome; the legs, which were micromammilate, lacked dorsal humps, and the disks on the dorsal surface of the body were large and conspicuous. They were identified as an *Ornithodoros* species of the *talaje* group. A critical examination of this group by comparison with specimens from the British Museum (Natural History) is now being made.

The presence of *Ornithodoros* in Britain is interesting for two reasons: (1) several species are well-known carriers of a number of important diseases; and (2) the genus has been regarded as confined to the tropics and sub-tropics. So far as we are aware, apart from this occurrence in Britain, the most northerly records of the species of the *O. talaje* group are from the Central and Eastern Mediterranean countries.

A second visit on June 9 to Puffin Island showed the incidence of *Ornithodoros* was much greater than we had hitherto imagined. The ticks were found under stones some twenty feet above high-water mark in a well-defined zone of soft fossiliferous calcareous shale which has been more extensively weathered and therefore recessed a foot or two between harder layers of Lower Carboniferous limestone. They occurred in this dry region in company with the beetle *Harpalus latus* (L.), the bristle tail *Petrobius maritimus* Ouds., the earwig *Forficula auricularia* L., and the mite *Molgus littoralis* (L.).

The rest of this small island was examined with the view of determining the distribution, and it was found that the ticks were present along the whole of the north-west cliff and around the north-east tip of the island, but only in places where this particular stratum was exposed. Numerous limestone outcrops, old limestone walls and a large number of nests of herring and lesser black-backed gulls over the top of the island were examined without success.

The numbers present on the island must amount to many thousands, for under small stones not more than six inches in diameter there were 10–100 ticks. The majority of these were in the adult stage, and a rough count showed that 1 per cent were engorged. Large numbers of egg clusters were also noted alongside adults during this second visit.

Although rabbits occur on the island, the main hosts were thought to be birds, and this was substantiated by the presence of avian blood in the engorged ticks. Curiously enough, the main concentrations of these ectoparasites were some way removed from any bird colonies, and in one or two instances the nearest nests on the same ledge were 70 ft. away, although nests up the cliff face were probably no farther than 40 ft. Nesting sites near the tick areas were examined, and one or two *Ornithodoros* were present in some nests of cormorant, shag, razorbill and herring gull. Many chicks of the last species occur on the rock ledges near the ticks and these are possibly the main hosts.

It is clear that this tick is well established as a breeding species in this locality. Whether it occurs in similar situations around the British Isles remains to be seen. We have taken the opportunity of examining the sea-bird colony on Bardsey Island, off the tip of Caernarvonshire, but no *Ornithodoros* were found. However, it is of interest to note that the ixodid tick, *Haemaphysalis punctata* (Can. et Fanz., 1877), which has hitherto been recorded in the British Isles only from south-east England, was common here in rough pastures.

J. Hobart
P. E. S. Whalley

Agricultural Zoology Laboratory,
University College of North Wales,
Bangor.
July 30.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 15

UNIVERSITY OF LONDON (at Guy's Hospital Medical School, St. Thomas' Street, London, S.E.1), at 5.15 p.m.—Dr. Christian Hamburger (Copenhagen): "The Excretion of 17-Ketosteroids in Human Urine".*

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. E. C. Cherry: "Information Theory".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Has Nuclear Fission a Future as a Source of Industrial Power?".

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. C. Tanner: "The Statistical Approach to Crop Protection Research".

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Strand, London, W.C.2), at 6 p.m.—Dr. Alexander King: "The Work of International Organizations and Foreign Documentation Centres".

Tuesday, November 16

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. C. W. Allen: "Activity in the Sun's Atmosphere".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 2.30 p.m.—Celebration of the Jubilee of the Thermionic Valve. The Most Honourable the Marquess of Salisbury, K.G., P.C.: Opening Address; Prof. G. W. O. Howe: "The Genesis of the Thermionic Valve"; Sir Edward Appleton, F.R.S.: "Thermionic Devices from the Development of the Triode up to 1939"; Dr. J. Thompson: "Developments in Thermionic Devices since 1939".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS, in the Science Museum Lecture Theatre, Exhibition Road, London, S.W.7), at 4.30 p.m.—Dr. J. W. L. Köhler (Eindhoven): "Gas Refrigerating Machines".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. V. Jelley: "Čerenkov Radiation".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. A. Tumarkin: "On the Function of the Middle Ear—Evolution and Degradation".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. N. A. Hawthorn: "The Electrical Properties of Plastics".

INSTITUTION OF MECHANICAL ENGINEERS, HYDRAULICS GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Measurement of Flow".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. T. Goodwin: "Uses of the 'Ace' Computer".

Wednesday, November 17

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. F. L. Warren: "Electrophoresis of Plasma Proteins".*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Leslie H. Lampitt: "Science and Food Production" (E. Frankland Armstrong Memorial Lecture).

INSTITUTE OF PETROLEUM (at the Royal Institution, Albemarle Street, London, W.1), at 4.30 p.m.—Mr. C. A. P. Southwell: "Winning Petroleum—a Story of British–American Co-operation" (Cadman Memorial Lecture).

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 4.45 p.m.—Discussion on "Water Supply".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Lord Piercy of Burford, C.B.E.: "The Macmillan Gap and the Shortage of Risk Capital" (Inaugural Address of the President).

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Christopher Ounsted: "Genetic and Social Aspects of the Epilepsies of Childhood".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. H. Heywood: "The Microscopes of John Marshall".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the Institute of Metals, Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Annual General Meeting. Sir Harry Jephcott: "Professional Status".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, S.W.1), at 7.30 p.m.—Captain J. L. Pritchard, C.B.E.: "Bird Flight and the Aeroplane" (Graduates' and Students' Section Lecture).

Wednesday, November 17—Thursday, November 18

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1)—Autumn General Meeting.

Wednesday, November 17—Saturday, November 20

NATIONAL PHYSICAL LABORATORY (at Teddington, Middlesex)—Symposium on "Precision Electrical Measurements".

Thursday, November 18

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting. Mr. W. A. Sexton: "Chemotherapeutic Research at the Laboratories of Imperial Chemical (Pharmaceuticals), Ltd., at Manchester".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. H. Jeffers: "The Collected Correspondence of Richard Pulteney, M.D., F.R.S. (1730–1801)"; Mrs. P. D. Wilson: "Mrs. A. W. Griffiths of Torquay and the Early History of Marine Botany in Britain".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. C. J. Beavis: "The Use of Electricity in the Production of Calcium Carbide".

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. Kramers (Delft): "Heat and Mass Transfer. 1: Unsteady States".*

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. A. G. Everson Pearse: "Histochemistry and its Applications to the Basic Sciences"*. (From a series of lectures on "The Scientific Basis of Medicine".)

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. L. J. Wood: "The Constitution and Structure of Coal Tar Pitch".

CHEMICAL SOCIETY (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. M. J. S. Dewar: "Molecular Rearrangements" (Tilden Lecture).

Friday, November 19

ROYAL SOCIETY OF MEDICINE, EPIDEMIOLOGY AND PREVENTIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Discussion on "The ABO Blood Groups and Disease". Opening speakers: Prof. Ian Aird, Miss A. M. Dickins and Dr. J. A. Fraser Roberts.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Captain F. J. Wylie, R.N.: "The Cause of 'Radar-assisted Collisions'".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. G. W. H. Gardner: "Guided Missiles" (James Clayton Lecture).

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. Kramers (Delft): "Heat and Mass Transfer. 2: Gas Absorption".*

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. G. E. Foster: "The Analyst in the Fine Chemicals and Pharmaceutical Industries".

BRITISH GLACIOLOGICAL SOCIETY (in the Geology Department, The University, Oxford), at 8.15 p.m.—Discussion meeting on "Recent Trends of Glacier Fluctuations in the North Atlantic Area". Speakers: Mr. M. M. Sweeting, Mr. C. W. M. Swithinbank and others.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Models of Metal Structure".

Saturday, November 20

NUTRITION SOCIETY (in the Clinical Lecture Theatre, Middlesex Hospital Medical School, Mortimer Street, London, W.1), at 10.15 a.m.—Symposium on "The National Food Survey of Great Britain".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Harry Luke: "Easter Island".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYTICAL CHEMIST (with an appropriate university degree or Associate of the Royal Institute of Chemistry, and preferably with some experience in an industrial laboratory) IN THE CENTRAL LABORATORY—The Chief Personnel Officer, North Western Gas Board (Liverpool Group), Radiant House, Bold Street, Liverpool 1 (November 17).

LECTURER (with a university degree in engineering, some industrial experience, and preferably some teaching experience) IN MECHANICAL ENGINEERING—The Principal, Dudley and Staffordshire Technical College, Dudley (November 19).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (November 20).

SENIOR LECTURER (with high academic qualifications and able to teach to special (honours) degree standard) IN THE MATHEMATICS DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (November 20).

JUNIOR ASSISTANT PHYSICIST (with a good honours degree and preferably some postgraduate experience) IN THE DEPARTMENT OF PHYSICS APPLIED TO MEDICINE, Middlesex Hospital Medical School—The Secretary, Barnato Joel Laboratories, The Middlesex Hospital, London, W.1 (November 22).

LECTURER (with a good honours degree) IN GEOGRAPHY, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 22).

SCIENTIFIC OFFICER (with an honours degree in bacteriology, or an honours degree in science with a diploma in bacteriology, and preferably with a good knowledge of chemistry) IN THE BACTERIOLOGY DEPARTMENT—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (November 22).

ASSISTANT (with a degree or equivalent in mathematics or statistics) for numerical and computational work arising from mathematical and statistical research on animal and plant populations—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (November 27).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in mechanical engineering or physics, with appropriate experimental experience and some knowledge of thermodynamics) IN THE NAVAL AIR DEPARTMENT of the Royal Aircraft Establishment, Bedford, to take charge of a section responsible for research, development and testing of catapults for launching aircraft from carriers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.728/54A (November 27).

ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (November 30).

LECTURER, Grade II (preferably with industrial experience in the development of electrical machinery) IN ELECTRICAL ENGINEERING—The Registrar, The University, Birmingham 15 (November 30).

SENIOR LECTURER (graduate of a British university, with appropriate qualifications and experience) IN PHYSICS, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, November 30).

TECHNICAL ADVISORY OFFICERS (with a degree in botany or agriculture or a recognized diploma in agriculture or horticulture, and preferably with a leaning towards, and experience in, grassland work), for work which involves the giving of advice to affiliated clubs and subscribing organizations on all matters concerning the establishment and maintenance of turf—The Director, Sports Turf Research Institute, St. Ives Research Station, Bingley, Yorkshire (November 30).

RESEARCH ASSISTANT (preferably with experience of electronics) IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Singleton Park, Swansea (December 1).

RESEARCH OFFICER (with a university honours degree in science or in veterinary science with physiology as a major subject, or equivalent qualifications) AT THE SHEEP BIOLOGY LABORATORY, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Great Western Highway, Prospect, New South Wales, Australia, to undertake investigations on the endocrinology of wool growth—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 205/55 (December 4).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university degree in veterinary science or equivalent qualification and postgraduate research experience) AT THE MACMASTER ANIMAL HEALTH LABORATORY, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Parramatta Road, Glebe, New South Wales, to undertake investigations on parasitological problems of sheep, with particular reference to the control of liver fluke and to the development of and use of new anthelmintics—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 202/98 (December 4).

CHAIR OF HISTORY AND PHILOSOPHY OF SCIENCE tenable at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 6).

CHAIR OF PHILOSOPHY—The Secretary, The University, College Gate, St. Andrews (December 6).

ASSOCIATE PROFESSOR (with a degree in science, engineering or metallurgy, with postgraduate research experience, and preferably some industrial experience) OF METALLURGY, at Newcastle University College, New South Wales, Australia—The Agent General for New South Wales, 56–57 Strand, London, W.C.2 (December 21).

ASSISTANT EXPERIMENTAL OFFICER (with at least H.S.C. or equivalent, and preferably conversant with radioactive measuring instruments) to assist in the development of prototype nucleonic instruments (Ref. 244/WGE/2); an EXPERIMENTAL OFFICER and an ASSISTANT EXPERIMENTAL OFFICER (with at least H.S.C. in physics or equivalent) for research into the physical and mechanical properties of radioactive metals and alloys (Ref. 273/WGE/2); and an EXPERIMENTAL OFFICER (with at least H.S.C. and a knowledge of physical chemistry and some experience in chemical engineering) to assist in development work on high explosives on the plant scale and in the laboratory—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

ASSISTANT LECTURER (graduate, with experience in teaching or in industry) IN THE SCHOOL OF PHYSICS—The Registrar, College of Technology and Commerce, Leicester.

ENGINEERS and PHYSICISTS (with an appropriate first- or second-class honours degree or equivalent high professional attainments), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A.

HONOURS GRADUATE for work involving a study of continuous fermentation on laboratory scale, and operation of small continuous culture plant—The Director, Antibiotics Research Station, 4 Elton Road, Clevedon, Somerset.

LECTURER (with a good honours degree) IN ELECTRICAL ENGINEERING—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

MATHEMATICAL PHYSICISTS (with a first- or second-class honours degree in mathematics or physics, together with some years appropriate postgraduate experience) for work in one of the following fields: astrophysics, fluid dynamics, nuclear physics or statistics—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 283/WGE/54.

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in physics or engineering, and with considerable research and development experience in the instrument-electronics field or related system of engineering in the aircraft industry) at the Royal Aircraft Establishment, Farnborough, Hants, to take charge of a project group responsible for the development in industry of a guided weapon—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.306/54A.

TECHNICAL ASSISTANT (graduate chemist) IN THE PATENTS DIVISION—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Colonial Office. Malnutrition in African Mothers, Infants and Young Children. (Report of the Second Inter-African Conference on Nutrition held under the auspices of the Commission for Technical Co-operation in Africa South of the Sahara (C.C.T.A.), at Fajara, Gambia, 19th–27th November, 1952.) Pp. 398 (56 plates). (London: H.M. Stationery Office, 1954.) 25*s.* net. [19

Shift Work. By F. P. Cook. Pp. 36. (London: Institute of Personnel Management, 1954.) 4*s.* [19

Science Museum, London. Book Exhibition Number Three: Historic Astronomical Books—Catalogue. Pp. 29. (London: H.M. Stationery Office, 1954.) 2*s.* net. [19

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1952–53. Queensland. By R. W. Peters. Pp. 10. 9*d.* Tanganyika Territory, Eastern Province. By E. W. Valentine. Pp. 9. 9*d.* Survey of Reports. By J. B. Hutchinson. Pp. 14. 9*d.* (London: Empire Cotton Growing Corporation, 1954.) [19

Department of Scientific and Industrial Research. Report of the Food Investigation Board, with the Report of the Director of Food Investigation, for the year 1953. Pp. iv+56+4 plates. (London: H.M. Stationery Office, 1954.) 3*s.* 6*d.* net. [19

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1953. Pp. 218+13 plates. (Long Ashton, Bristol: University of Bristol, Department of Agriculture and Horticulture, 1954.) 15*s.* [19

Other Countries

Department of the Army—Corps of Engineers. Beach Erosion Board—Office of the Chief of Engineers. Technical Memorandum No. 44: Coast Erosion and the Development of Beach Profiles. By P. Bruun. Pp. vi+79+2. (Washington, D.C.: Department of the Army, Corps of Engineers, 1954.) [278

Southern Rhodesia: Federal Ministry of Agriculture. Annual Report of the Grasslands Agricultural Research Station, Marandellas, S. Rhodesia, for the year ending 30th September, 1953. Pp. iv+69. (Marandellas, S. Rhodesia: Grasslands Agricultural Research Station, 1954.) [19

U.S. Department of Agriculture. Leaflet No. 364: Chinch Bugs: How to Control Them. Pp. 8. 5 cents. Farmers' Bulletin No. 2064. Grasshoppers: a New Look at an Ancient Enemy. By J. R. Parker. Pp. 40. 20 cents. Technical Bulletin No. 1090 (May 1954): Persistence of BHC, DDT, and Toxaphene in Soil and the Tolerances of Certain Crops to Their Residues. By Norman Allen, R. L. Walker, L. C. Fife, R. D. Chisholm, Louis Koblitsky, J. F. Bullock, C. R. Hodge and E. E. Hall. Pp. 19. 15 cents. (Washington, D.C.: Government Printing Office, 1954.) [19

Southern Rhodesia. Report of the Director, Geological Survey, for the year 1953. Pp. 11. (Salisbury: Government Printer, 1954.) [19

Report of the South African Museum for the period ended 31st March, 1954. Pp. 28. (Cape Town: South African Museum, 1954.) [19

Nigeria. Annual Report on the Forest Administration of the Western Region of Nigeria for the year 1952–53. Pp. iii+36. (Lagos: Government Printer; London: Crown Agents for Oversea Governments and Administrations, 1954.) 9*d.* net. [29

Survey of Research Problems in Plastics, with special reference to the Development of the Plastics Industry in India. Compiled under the auspices of the Plastics Research Committee. Pp. v+155+18 plates. (New Delhi: Council of Scientific and Industrial Research, 1954.) 5 rupees. [29

Annual Report of the Indian Council of Agricultural Research for 1951–1952. Pp. vii+181. (Delhi: Manager of Publications, 1954.) 3 rupees, 2 annas. [29

Bulletin of Endemic Diseases. Vol. 1, No. 1 (July 1954). Pp. 85. (Published provisionally at six-monthly intervals.) Subscription rate for 1 volume (4 issues) 20*s.*, 2.80 dollars. Single issues 6*s.* (Baghdad: Institute of Endemic Diseases, 1954.) [249

Fertilizing Flue-Cured Tobacco. Pp. 16. (Salisbury, S. Rhodesia: Tobacco Research Board of Southern Rhodesia, 1954.) [249

Federation of Malaya. Report on the Federal Forest Administration for the year 1953. By E. J. Shrubsall. Pp. vi+70+77 plates. (Kuala Lumpur: Government Printer, 1954.) 2 Malayan dollars; 4*s.* 8*d.* [249

Anais de Microbiologia. Vol. 2. Pp. 288+5 plates. (Rio de Janeiro: Faculdade Nacional de Farmacia, Universidade do Brasil, 1952/53.) [249